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ABSTRACT

Papers from a conference on information technology and teacher education are presented. The 225 papers address the following topics: diversity and international perspectives; reading and language arts; mathematics; science; preservice teacher education; the educational computing course; graduate and inservice projects; faculty development; methods, concepts, and procedures; hypermedia; simulation; instructional design; preservice use of telecommunications; graduate, inservice, and faculty use of telecommunications; research; constructivist theories; technology diffusion in elementary, secondary, and postsecondary institutions; and information technology and teachers of special needs populations. The articles are divided into sections according to topic; and an introduction to, and summary of the articles is provided at the beginning of each section. (Author/AEF)

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AACE ASSOCIATION FOR THE ADVANCEMENT OF COMPUTING IN EDUCATION

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Table of Contents

DEDICATION XVII
DIVERSITY & INTERNATIONAL 1
Dee Anna Willis, Marilyn Heath, Janice Larson, Michael L. Connell
Empowerment: Media Literacy Through the Precepts of a Global Multicultural Curriculum
Joanne Bodin 3
Computer Use in an Elementary Multicultural Classroom
Inés Márquez Chisholm 8
Multimedia Multicultural Instruction: Exploring Diversity with a Non-Diverse Student Population
Susan E. Anderson 13
Building Bridges: TESOL and Technolog
Karin M. Wiburg. Ana Huerta-Macias 17
A Model for International Education and Cooperation
Patrick J. Casey 22
Use of A Distance Training Program for Teachers of Mexican Indian Languages
Harold Ormsby 25
An English Course by and for Telecommunications
Diana Jenkins, Patricia Castillo-Schwartz 29
Creating a Space for Interactive Education: The Iberoamerican Association of Educational Television
Isabell Kempf 32
Multimedia Resources for Teaching Education: An Internationally Transferable Resource?
Toni Perle, Niki Davis 37
Teaching Teachers to Change: The Place of Change Theory in the Technology Education of Teachers
Brent Robinson 40
Comparing Attitudes Toward Computers of Polish and American Prospective Teachers
Marcin Paprzycki, Draga Vidakovic, Stanislaw Ubermanowicz 45
Training Students in Russia to Teach Mathematics with Information Technologies
Mikhail M. Bouniaev 49

China: Impressions and Continuing Connections
Nancy P. Hunt 53

Development and Dissemination of the First Major CMI System for Chinese Schools
Julie Qiu Bao 57

A Cross-Cultural Comparison of Computer Attitudes among Preservice Teachers
Yuen-kuang Cliff Liao 61

Experiences in the Development, Dissemination & Use of Computer Based Materials in India
K. Srirengan 66

Technology, Problem Solving and Gender Issues: A Focus For Teacher Change
Elaine Hutchinson, Sonja Kung 69

Observation and Analysis of Mathematics Students Using Computer Technology
Pamela T. Barber-Freeman 73

SOCIAL STUDIES 75
Cameron White

Technology and Civic Education: New Directions - New Issues
Richard A. Diem 76

Toss the Text: Integrating Telecommunications in Social Studies Teacher Education
Steven Marx 78

Preservice Teachers Develop Multimedia Social Studies Presentations for Elementary Grades
Steven H. White 83

Using Technology and Cultural Heritage to Provide Interpretive Learning Services
John D. Parmley, Art Hutchinson, Robert F. Hower, William R. Morris, Dianna L. Parmley 86

READING/LANGUAGE ARTS 89
Gregg Brownell, Nancy Brownell

A Distance Learning ESL Teacher Preparation Program Utilizing Both the "High and Low Roads" of Instructional Technology
Lynn E. Henrichsen, Marshall R. Murray 91

Technology's Role in Improving the Teaching and Learning of English Language Learners
Yolanda N. Padron, Hersholt C. Waxman 93

A National Survey of the Integration of Technology into TESOL Master's Programs
Mary Ellen Butler-Pascoe 98

Using the Internet in Graduate Language Teacher Education
Ronald J. Anderson 102

The Implementation of Technology into a Language Arts Methods Course: User Response to Stages of Writing Development
Nancy L. Williams, Kathryn I. Matthew 107

Teaching Early Childhood Language Arts and Technology: A Creative Integration
Keith Wetzel, S. Vianne McLean 110

Virtual Field Experience Utilizing Computer Networks and Interactive Television
Gayle Allen 115

A Model of Learning to Teach Writing with Computers
John Zbikowski, Alex C. Pan 118

Children's Literature: Linking Books and Technology
Denise Staudt 122

Creative Uses of E-Mail Texts in Foreign Language Teaching
Heike Rautenhaus 124

Interactive Television: A New Delivery System for a Traditional Reading Course
Betty Wheatley, Edrie Greer 128

Planning and Creating Interactive, Multimedia Lessons for Literature-Based Reading Programs
Betty Lou Land, Rhonda Taylor 132

Using CD-ROMs to Develop Automaticity and Fluency in Reading
Mary Jane Ford, Virginia Poe, Juanita Cox 136

MATHEMATICS **140**
Susan Williams, Juanita Copley

Making Mathematics Real for Preservice Teachers: Using the Internet
Dawn Poole, Michael Simonson 142

The Use of Student Tutorials in a Mathematics Education Course
Sandra B. Cooper 146

Multiple Indicators of Learning in a Computer Based Geometry Classroom
Patricia A. Pokay, Carla Tayeh 148

Exploring the Potential of Teacher Created Multimedia Materials as a Staff Development Tool
Sandra L. Atkins 152

Student Use of Technology to Build Links Between Mathematical Variables: Implications for Teacher Education
Michael L. Connell 155

The Skymath Project
Beverly T. Lynds, Myles Gordon 160

Interactive Mathematics Text Project
Vincent DeBlase, Sharon Wagner 163

Electronic Bulletin Board Systems (BBSs) and Student Teacher Education
DeLayne Hudspeth, Dennis Maxey 167

Teaching A Computer Notation for Secondary Mathematics
Howard A. Peelle 171

IT & Mathematics Teaching: New Roles for Teachers and Implications for Training
Paola Forcheri, Maria Teresa Molfino 176

A Framework for Reporting Performance on Problem-Solving Assessments: SPP Charts and Classroom Applications
Delwyn L. Harnisch 180

SCIENCE **185**
Jacqueline Forbes

Educating Teachers for Hands-on Science
Gerald Knezek, John Southworth, Rhonda Christensen, Greg Jones, David Moore 186

EarthVision: Teachers and Students Learn to Use High Performance Computing Together
Ralph K. Coppolam, Eva Erdosne Toth 191

Concept Attainment Model: A Viable Component for Elementary Science Curriculum
Mike Nelson, Alex C. Pan 197

Some Experiences of Using an Electronic Discussion List in a Course
M. O. Thirunarayanan 201

LabNet: An Electronic Forum to Support Teaching Science
Deborah Muscella, Vanessa Di Mauro 205

Young Engineers and Scientists: A Mentorship Program Using Information Technology
D.C. Boice, C.L. Redfield, Judith Hooper 210

PRESERVICE TEACHER EDUCATION **213**
James White, Andria Troutman, Tara Cooper, Connie St. Clair

Let the User Beware
Neva Ann Davenport 215

Preservice Teacher Computer Literacy and Performance Assessment
Steven Dickey, JoAnn Dickey 217

Helping Strategies on the Slippery Ladder to Competence and Confidence
Mike Boston, David Kay 219

Information Technology in the Students' First Year of Teacher Education - Developing Classroom Experience
Chris Taylor 223

From College Instructor to Second Grade Computer Teacher: I Learned My Lesson
Maggie Austin 227

Technology Instruction for Preservice Teachers: An Examination of Exemplary Programs
Royle Vagle 230

Technology in Teaching Methods Courses: Is it Happening?
Royle Vagle 238

The Uses of Hyperstudio
Nancy M. Wentworth, David Breithaupt 244

New Directions for Teacher Education in the Information Technology Age
Elizabeth Downs, Kenneth Clark, Jack Bennett 247

Integrating Technology into the University Teacher Education Curriculum in Music
Rodney Schmidt 250

Designing, Developing, and Evaluating a Laserdisc Program for English/Language Arts Teacher Education
Liz C. Stephens 254

Using Laserdisc Technology in Elementary Mathematics Education
John F. Riley, David M. Martin 259

Designer Programs for Teacher Education Classrooms
Janice L. Nath 261

Incorporating Technology into a Program for Three and Four Year Old Boys and Girls
Bob Lumpkins, Kay Rayborn, Margie Herrin, Fred Parker 265

Technology and Young Children: What Teachers Need To Know
Phyllis A. McCraw, Jane E. Meyer 268

Using Technology to Provide Authentic Learning Experiences for Preservice Teachers
Janice M. Stuhlmann, Harriet G. Taylor, Sue LaHaye 273

Innovative Ways of Integrating Technology into Student Teaching Experiences
Ron Zambo, Keith A. Wetzel, Ray R. Buss 278

Integrating Technology in Preservice Education: A Model For Faculty Development
Karen Kortecamp, William R. Croninger 283

Designing a Hypermedia Portfolio for Preservice Teachers
David Byrum, Judy A. Leavell 287

The Place for Technology in a Constructivist Teacher Education Program
Cameron White 290

Measuring Preservice Teacher's Information Literacy Skills: Implications
Bernadette Cole Slaughter, Blaine E. Knupp 294

From Reel to Reality
Dorothy R. Smith 297

Lecture in Teacher Education: A Renewed Point of View
Martti Silvennoinen 301

Implementing Computer Technology in a Teaching Methods Class
John Ronghua Ouyang 305

THE COURSE **308**
Trudy Abrahamson

The Evolution of Computer Literacy for Preservice Teachers
Janice Higdon 310

Needed for Students: More TLC (Technology and Learning Cooperatively)
Joan Cook, Linda Cimikowski 314

Computer Literacy Class for Preservice Teachers at University of Texas at Austin
Peg Raiford, Laura Braulick 318

Technology "R&D" for Preservice Teachers
Catherine Collier, Margaret McDevitt 322

Adding a Field-based Component to a Course in Educational Computing
Jenny Burson 326

Enhancing Preservice Teachers' Computer Attitudes Using a Field-Based Educational Computing Course
Lily L. Wright, James Y. H. Zhang 329

What If We Teach Integration, Not "Computers"?
Elizabeth M. Willis 331

Meeting Pre- and Inservice Teachers' Changing Needs Through Technology: Considerations for Curriculum, Classroom, and Teacher Roles
Jan Flake, Laurie Molina 335

GRADUATE & INSERVICE **341**
Bernard Robin, Eric Lloyd, David Robinson, Theron Ray Schultz

An Evaluation of Project EXCEL Teacher Inservice Program
Keith A. Wetzel, Ines M. Chisholm, Ray R. Buss 343

Teaching Teachers to Teach with Technology: A New Program
Glenda A. Gunter, Diane T. Murphy 348

ITS Changing Teachers' Paradigms
Debra Sprague 352

Teaching Elementary and Middle School Teachers about Technology: An Example from NASA
Randal Carlson, Lynn Lambert 357

Project Infusion: Teachers, Training, and Technology
Patty LeBlanc 362

Designing Technology Staff Development: A Phased Approach
Bernard Robin, Robert Miller 366

Electronic Technologies, Educational Change, and the Narrative: An Experiment in Graduate Education
Priscilla Norton 371

Is There Really Life During Statistics?
Leona P. Dvorak, Elizabeth M. Willis, Karen L. Tidler, Joseph G. R. Martinez 376

Basic Criteria for Selecting and Evaluating Instructional Software
Kay Persichitte 379

Training Teachers: An Introduction to the Training Component of the Houston Independent School District
Linda McDonald Lemons 383

Walking Our Talk: Six Practical Technology Suggestions for Teacher Educators
Thomas A. Drazdowski 387

The Internet as an Interactive Medium in Graduate Teacher Training
LaMont Johnson, Steven Harlow, Cleborne D. Maddux 390

Configuring Graduate Coursework for Delivery via Internet
Anthony J. Scheffler, Maria Betancourt-Smith, David Kirkwood 394

AV to Internet: Integration of Technology in Education
Ray E. Wong, R. Michael Smith 398

Establishing Institutional Partnerships and Reshaping Instruction
Via Interactive Distance Learning
Mary Jane Bradley, Mitch Holifield, Beverly Bartels 401

FACULTY DEVELOPMENT 404
Jenny Burson, Jerry Price, Brandie Colon, Gita Varagoor

A Faculty Development Model for Distance Learning Systems
Elizabeth Downs 406

A Model for Technology Infusion in Higher Education
Michael R. Hoadley, Jeri L. Engelking, Larry K. Bright 410

Collegial Consultants: Employing an Entrepreneurial Model
for Technological Literacy
Susan R. McIntyre 414

The Next Generation: Going Beyond the Models
Nancy G. Mims, Barbara K. Mc Kenzie 419

Faculty Technology Development Model
Terry R. Smith, Kathryn A. Smith, Karenlee Alexander 423

METHODS, CONCEPTS, & PROCEDURES 427
Deborah Bauder, Ronald Sarner

Incorporating Technology into Problem-Based Learning
Donn Ritchie, Peter Norris, Gina Chestnutt 429

Computers in the classroom: A license to skill
Christene K. Bennett, Jerry A. Bennett, Pamela E. Tipton, Curt Tarter 434

Establishing Technology Communities for At-Risk Students
Dorothy Erb, Constance S. Golden 437

Making Connections: Using Information Technology
as a Vehicle for Restructuring Curricula
Gail F. Grejda 442

Tech Camp: A Model Institute for Integration of Technology and Education
Katherine Will, John Clementson, Oscar H. Will, III 443

Information Technology in the Classroom: A Model Approach
Cheryl Moser 447

One Teacher Education Program's Answer to Technology Integration
Lorana A. Jinkerson 451

Growing Our Own: Database Tending in Colleges of Education
Gary G. Schroeder 455

Publishing Partners: A University/School Collaboration to
Publish a Technology Text
Gregg Brownell, Nancy Brownell 460

Selected Case Studies in Internet Based Post-Secondary Distance Education
Thomas McManus 464

HYPERMEDIA/MULTIMEDIA **468**
Ray Braselll, Jerry Price, Michael L Connell

Software Development for a Microteaching Laboratory
Ronald J. Abate 470

The Process of Developing Interactive Multimedia Materials for
Preservice Education: Negotiation, Collaboration, Presentation
Sandra L. Atkins 474

The Evolution of Videodisc and Technology Use for an
Educational Psychology Course
c. lynne hannah, Kathleen T. Benghiat 477

Flexibility is the Key to Video-Based Classroom Management Presentations
Kathleen T. Benghiat, Thomas W. Frew 480

Helping Teachers Implement Interactive Multimedia:
A Case Study of the Use of Encarta in the Classroom
Patti R. Baker-Albaugh 483

Teacher Talk: Capturing Innovative Teacher Voices in a
Multimedia Internet Environment
Kris Bosworth, Paul Haakenson, Kevin McCracken 488

Fidelity and Moral Authority: Ethical Issues in Videodisc Design
Katy Campbell, Laurie Bowers, Graham Fishburne 493

Practical Classroom Uses of HyperCard
Vince DeBlase, Craig Huller 497

Empowering Teachers to Develop MultiMedia Software Applications
Jeri L. Engelking, Michael R. Hoadley, Robert A. Jenson 500

Teachers as Authors: HyperCard Projects for the Classroom: A Case Study
María Teresa Fernández 503

HyperCard for Children: A Case Study and Suggestions for Teachers
Jerry P. Galloway 507

Odyssey of Developing Creativity with Computers: Speeding Train or Brick Wall?
Sharla L. Snider, Vera T. Gershner 511

The Design/Implementation of a Multi-Media Teaching Tool
for Preservice Teacher Education
Sue P. Reehm, MaryAnn Kolloff, Shirley A. Long 516

Use of Videodisc Technology in Early Childhood Education: Implications for Teacher Training
Monique Manuel, Min Liu *519*

Selecting Appropriate Hypermedia Authoring Packages for Courseware Development
Thomas J.C. Smyth *524*

Educational Multimedia and Dewey's Reconstruction of Experience: Practical Considerations
Gene Sullivan *526*

Beethoven's a Dog; Rafael's a Ninja Turtle; Should Rembrandt be a CD-ROM?
John A. Swartz *531*

Beginner's Guide to Multi/Hypermedia Development with Visual BASIC
James A. White *533*

Repurposing the Level II Alberta Videodiscs for Level III Use
Jerry Willis, Clare M. Walsh, Gita Varagoor *537*

SIMULATION **541**
Harold Strang, Alice Strang

Assessing Teaching Deliberation via a Computer-based Teaching Simulation
Harold R. Strang, Jake Mazulewicz *543*

Assessing Teacher Ethnic and Gender Biases via a Teaching Simulation
Harold R. Strang, Yu-chu Yeh *546*

From Trait Optimism to Simulated Teaching Experience
Susanne M. DeFalco, Harold R. Strang *550*

INSTRUCTIONAL DESIGN **554**
Jenny Burson, Jerry Price, Brandie Colon, Gita Varagoor

Factors Limiting Technology Integration in Education: The Leadership Gap
Ray Cafolla, Richard Knee *556*

Learning Criteria for Multimedia Lessons
David G. Craig *561*

Recursive Templates in Multimedia Presentations
Brian G. Mackie, James E. Corbly *564*

Teaching Word Processing to Teachers: A Working Model
Alex C. Pan, Doris Lee *567*

Technology Activities: New Ideas for Teaching
William J. Valmont, Carlos A. Blanco *571*

Producing Electronic Books: Creating and Using the CD-ROM Version of the Annual
Linlin "Irene" Chen, Jerry Willis *575*

TELECOMMUNICATIONS: PRESERVICE **579**
Glen Bull, Roger Geyer

Teacher Education and the Internet: Where Do We Go From Here?
Cleborne D. Maddux, LaMont Johnson, Steven Harlow 581

The Teacher's Ultimate Classroom Resources: Mosaic and the World Wide Web
Roger W. Geyer, ... 587

Multimedia Telecommunications: Services for Professional Development
Linda Baggott , Niki Davis , Bruce Wright 588

Creating Listserv Lists for Teacher Education Enhancement
Sue Espinoza, Evan Yeager 592

Telecommunication Projects Designed for Preservice Students
Cathy.Gunn 596

Using Telecommunications to Connect Preservice Teachers and Classrooms
Phillip Makurat 600

LearningNet and EastNet: Creating a University/Business/Schools Partnership
Emmett M. Floyd 603

WCUMicroNet: Putting Purpose into the Network
Bonnie J. Beam 606

Interactive Technologies in Teacher Recruitment: Linking School to College
Gregg C. San Nicolas, Anthony C. San Nicolas 609

Constructing Cultures in Distance Education
L. Adrianne Bonham , Lauren Cifuentes, Karen L. Murphy 614

A Look at Communication Patterns on the MariMUSE:
Understanding How Children Learn
Sara Olin Zimmerman, Ward Zimmerman, Michelle Capen, William Blanton 618

Throw Me a Rope: A Distance Learning Faculty Guide
Michael Clay, Robert Grover 621

Internet Initiatives for Teacher Education
Sue Espinoza, LeAnn McKinzie 626

Instructional Use of the Internet: Role of Teacher Education
Bert I. Greene, Jerry Robbins, James Riley, James Barnes 631

TELECOMMUNICATIONS: GRADUATE, INSERVICE, & FACULTY USE 636
Bernard Robin, Eric Lloyd, David Robinson, Theron Ray Schultz

Internet Outposts: Communication Patterns in Computer-Mediated Classrooms
Hilda Lee Williams, Eunice M. Merideth 638

Computer-Mediated Communication: Facilitating Dialogues
Patricia A. McGee, Victoria Boyd 643

Interdisciplinary Curriculum Development using Telecommunications
Eileen E. Schroeder, Anne Zarinnia, David Griffey 648

A Model for Inservice Teachers, Preservice Teachers, and
Methods Faculty Learning to Drive on the Information Highway
Diane D. Kester, Betty G. Beacham 652

Developing an Electronic Infrastructure to Support Site-Based Teacher Education
Robert Miller, Bernard Robin *656*

Professional Development and the Internet: Experiences of Common Knowledge: Pittsburgh
Gail Clark Futoran, Richard Wertheimer *661*

The Career Development Program and Telecommunications: Research in Progress
Gregg McMann *665*

Creating a "Learning Culture" in the Electronic Graduate Seminar
Dale C. P. Howard, Peggy Ann Howard *668*

The Electronic Emissary: Design and Initial Trials
Greg Jones, Judi Harris *672*

Technology 'Nformation for Teachers
Andria P. Troutman, Lara Kiser, Carol A. Seifreit *677*

An Electronic Newsletter for an IT Graduate Program: Steps and Strategies
Theron Ray Schultz *680*

The End User of Internet: Integrating Technology into the Classroom
Marlene Goss *683*

TEAM: A Paradigm for Learning in Graduate Education with Technology
Bette E. Schneiderman, Michael M. Byrne *685*

The Rochester Area Interactive Telecommunications Network (RAITN) and its Impact on Teacher Education: A Progress Report
Morris I. Beers, Mary Jo Orzech *690*

Planning to Receive a Teleconference on Campus
Judy A. Leavell, David Byrum *693*

Effectiveness of T1 Telecourse Delivery on Mathematics Instruction
Jim Dorward, Kathleen Trezise *696*

Designing a Wide Area Telecommunications Network: Factors to Consider
David Robinson *705*

Teaching Teachers to Use Telecomputing Tools: Formats and Tips
Judi Harris *706*

Evolution of the Teacher Education Internet Server
Bernard Robin, Glen Bull, Frank Becker, Jerry Willis *710*

Special Considerations for Designing Internet Based Instruction
Thomas McManus *715*

A Tutorial Simulation to Introduce Teacher Education Students to USENET
Seung H. Jin *719*

Multimedia Telecommunications: services for professional development
Linda Baggott, Niki Davis, Bruce Wright. *725*

RESEARCH **729**
Jerry Willis, Seung Jin, Irene Chen, Kerry Haner

Computers and Teacher Education Students: A Ten-Year Analysis
W. Michael Reed, Daniel K. Anderson, Joseph R. Ervin, Jr., John M. Oughton 730

Turning Points: The Effects of Staff Development Using Technology in Professional Development Schools
Alice Manus, Jon Denton 735

Relationships Among Experience, Philosophy and Beliefs Related to Calculator Use
M. Jayne Fleener 742

Research Project: An Appraisal of the Impact of Nebraska's Statewide Internet Implementation
Neal Topp, Neal Grandgenett, Bob Mortenson 743

Field-Based Student Attitudes and the Integration of Technology
Dion Dubois, Wayne Linek, Karen Gentsch, John McEneaney 747

State Technology Curriculums: A National Survey
Ward Alexander Zimmerman, Sara Olin Zimmerman, Ward Brian Zimmerman 750

Technology in Teacher Education — Faculty Attitude, Knowledge and Use
Veronica J. Lyons, Randal D. Carlson 753

Faculty Images of Technology Integration in Teacher Education
Sharon K. Kraus, Lee A. Kraus 758

Educational Technology: School Administrators Voice What Teacher Candidates Need to Know
Lorana A. Jinkerson 761

Are We Meeting Students' Needs in Instructional Technology?: Student Perceptions
Barbara K. McKenzie, Matthew N. Clay 764

Teacher Education Students' Attitudes Toward Educational Computing
Shwu-yong L. Huang, Hersholt C. Waxman, Yolanda N. Padron 769

From Coursework to the Real World: First-Year Teachers and Technology
Neal B. Strudler, Linda F. Quinn, Marilyn McKinney, W. Paul Jones 774

Considerations Before, During and After Using Technology in a Classroom
Andrew Tellep, Michele M. Tellep 778

Effects of Technology Use on Classroom Instruction in Middle School Mathematics
Hersholt C. Waxman, Shwu-yong L. Huang 781

Review of Research on the Use of Interactive Videodisc for Training: Executive Summary
Joanne Capper 786

Recent Graduate Perspectives on Instructional Technology: A National Survey
Brandie Colón, Jerry Willis , Dee Anna Willis, Linda Austin 791

Faculty Perspectives on Instructional Technology: A National Survey
Jerry Willis, Dee Anna Willis, Linda Austin, Brandie Colón 795

The Current Status of Technology Teacher Education:

An International Comparison
Niki Davis, Jerry Willis, Kathleen Fulton, Linda Austin 801

Profiles in Progress: Case Studies of Exemplary Technology
and Teacher Education Programs
John R. Mergendoller, Jerome Johnston, Saul Rockman, Jerry Willis 805

THEORY **808**
Jerry Willis, Kerry Haner, Irene Chen, Seung Jin

Using Anchored Instruction in Inservice Teacher Education
Donna Baumbach, Sally Brewer, Mary Bird 809

An Epistemological Examination of Computer Telecommunications
Steven D. Harlow, D. LaMont Johnson, Cleborne D. Maddux 814

Some Thoughts About Applying Constructivist Theories of Learning
to Guide Instruction
Yuan Feng 816

An Introduction to Constructivism in Instructional Design
Elissa Fineman, Sandy Bootz 820

Cognitive Structuring of a Historical Event Read from Computer Hypertext
Susan D. Heide. 824

Toward Combining Programmed Instruction and Constructivism
for Tutorial Design
Karen Smith-Gratto 828

Cooperative Learning Ventures Using Microsoft Products
and Other Selected Programs
Leticia Ekhaml 831

TECHNOLOGY DIFFUSION **834**
Nancy Hunt, Neal Strudler, Keith Wetzel

Technology and Change in Colleges of Education
John P. Dolly 836

Goal: Technology-Using Teachers; Key: Technology-Using Education Faculty
Neal W. Topp, Robert Mortenson, Neal Grandgenett 840

Collaboration between the California State University and
the University of California for More Extensive Teacher Taining Programs
Rosemary Papalewis 844

Regional Collaboration on School Reform:
Overview of the Monterey Bay Regional Computer Network
Marti Atkinson 846

Innovation, Information, and Teacher Education
Edward John Kazlauskas 851

Presenting Teachers With A Model for Technological Innovation
Patrick J. Casey 855

A Handbook for Technology Implementation
M. J. "Mimi" Schuttloffel 859
Technology for Instructional Leaders: A School-University Collaboration
Christene K. Bennett, Pamela E. Tipton, Jerry A. Bennett 863
Assessing Teachers in a Telecommunications Initiative Using the Concerns-Based Adoption Model
Janice M. Stuhlmann 868
Technology Changes Curriculum: Or Does It?
Mary S. Anderson 872
Evaluation of a Program Introducing MIDI Keyboards into Five Schools
Henryk R. Marcinkiewicz, James C. Moore, Julie Baumberger 876
Making Barriers Explicit: Some Problems with the Computer Innovation Literature
Peter Twining 879
Telecommunications: A "Hook" to Facilitate the Infusion of Technology Throughout Teacher Education Programs
Ann D. Thompson 883
Cooperative Learning with Hypermedia
Bob Gillan, Dion Dubois 886
INFORMATION TECHNOLOGY & TEACHERS OF SPECIAL POPULATIONS 888
Dee Anna Willis, Marilyn Heath, Janice Larson
Learning, Technology, and Special Needs: A Videodisc Sampler
Eileen Pracek, Donna Baumbach 889
Technology for Educators: A Graduate Program for Research and Practice
Sarah McPherson 892
Three-minute Videos: Effective Solutions for Reducing Anxiety and Promoting Achievement
Maryanne R. Bednar, John J. Sweeder 894
Addressing Attention-Deficit/Hyperactivity Disorder Through Technology: Implications for Teacher Education Programs
Evelyn M. Dailey 897
Computers as Tools for College Courses: A Pilot Study
Peggy Anderson 901
AUTHOR INDEX 907

Dedication to

Mary Milo Planow

The 1995 Technology and Teacher Education Annual, is dedicated to the memory of Mary Milo Planow, Assistant Professor of Computer Science at the State University of New York Institute of Technology at Utica/Rome, who succumbed to cancer at far too young an age in October 1993.

Mary's dedication to her profession was displayed in her teaching, research, scholarship, and community service. She was a role model for her colleagues, her students, and members of her community.

Mary touched the lives of many students in her teaching career. She was noted as a caring instructor, advisor, and mentor to her students. Before the concept of modeling educational innovations was in vogue, Mary did just that. She taught in a computer classroom for years, and it was those experiences that enriched her instructional technology classes. Collaborative learning and authentic assessment were part of Mary's repertoire long before the current trends. Mary developed the Institute's Computer Science Internship Coop Program, giving students opportunities to learn and work in local business and industry settings.

Mary's interest in teaching extended to the K-12 sector as well. In response to concerns of area teachers, Mary conducted a needs assessment that ultimately lead to a series of state and federally funded inservice programs for elementary and secondary teachers in the central New York area. More than one hundred teachers have taken part in these inservice programs, and have shared skills learned with their peers.

Research and scholarship in the profession became part of Mary's life, as she co-authored seven papers in four years, and gave numerous presentations at state and national conferences. Mary was a charter member of the Society for Technology and Teacher Education, now SITE. Mary was also a member of the International Society for Technology in Education, the Association for Computers in Mathematics and Science Teaching, and the New York State Association for Computers and Technology in Education. Her interests in educational technology and computer science led her to pursue a doctorate in Information Science at the State University of New York at Albany.

In community service, too, Mary was an educator. Mary was a member of the policy board of the Holland Patent Teacher Center, and a member of the school district's technology committee. She was also active in the local 4-H organization, serving as a club leader and assisting at county and state fairs.

This organization and its members were indeed privileged to have enjoyed a warm personal and professional association with Mary Milo Planow. May her memory serve as an inspiration to us all.

Deborah Y. Bauder and Ronald Sarner, State University of New York Institute of Technology at Utica/Rome

DIVERSITY & INTERNATIONAL

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One of the joys of editing the Annual is hearing from people all over the world who are involved in information technology and teacher education. There is a certain commonality in their trials and tribulations, their joys and successes, that transcends political divisions and geographic boundaries. The settings may be quite different, but in dealing with change and human factors several truths (lower case intended) emerge—it isn't simple and it isn't easy, but using technology to improve instruction for children is worth the effort.

Another job related to the Annual is deciding what papers go into which section. As with many things it is not an easy job—most of the papers in this section could have gone into any of several other sections—telecommunications, multimedia, preservice teacher education, for example. But because these provide new windows on our diverse world, they were chosen for this section. Because the papers themselves consider a wide variety of experiences in technology and teacher education, deciding on the order of papers was also a challenge. Having been raised on *National Geographics* I decided to take a world trip perspective, anchoring each end with more global concerns. (Just seeing the various postage stamps provided a visual trip around the world.)

This section begins and ends with two issues that concern many of us—first, multiculturalism in our pluralistic societies, and last, gender issues. In between we travel all over the world, first going to Mexico, to Costa Rica, and then to Chile. From South America we sail to England and from there across the rusty ashes of the Iron Curtain to Poland and Russia. From Russia we take several looks at China and then end our journey in India. Unlike C. Columbus we traveled east to reach the Indies.

The first papers address technology and multicultural issues in education. Technology can augment an ongoingocess of the rich getting richer, the poor, poorer. Or it can empower all. Bodin (University of New Mexico) alerts us to the need to help children develop *media literacy*, empowering them to critically evaluate messages, covert as well as overt, delivered by electronic media. Chisholm (Arizona State University West) discusses ways teachers may use technology to meet the diverse needs of children in multicultural classrooms. Anderson (Texas Christian University) tells how she sensitizes a non-diverse population to the needs of a multicultural classroom. Using technology in an educational psychology course Anderson prepares preservice teachers to work effectively with an increasingly diverse school population.

A significant part of our diverse population will not be native English speakers. The next article suggests ways to prepare teachers to be successful with these children. Wiburg and Huerta-Marcias (New Mexico State University) drew on their teaching areas to design a six-unit course providing three hours in both Teaching English to Speakers of Other Languages (TESOL) and Instructional Technology. Course requirements include three technology projects and the development and publication of a class book on ESL resources for teachers.

The next four papers explore a number of programs in Latin America. Casey (University of Hartford) describes a collaborative Masters program of the University of Hartford and the Fundacion Omar Dengo of Costa Rica. This program uses the *teachers teach teachers* model to facilitate buy-in, but it also provided the teachers with continued support, and training for additional tutors. In Mexico, a renewed interest in saving indigenous languages and recognition of the cultural importance of native languages has led to a growing demand for language teachers. Ormsby (Centro de Investigaciones Y Estudios Superiores en Antropología Social) writes eloquently of the development of a distance education program to train teachers of Mexican Indian languages. A second Mexican program, also designed to meet a need, is reported by Jenkins and Castillo-Swartz (National Autonomous University of Mexico). This course combines English and computer literacy for educators through telecommunications. Kempf's (UNESCO) article also describes a distance teacher education project; however, this one involves the development of interactive educational television using HISPASAT, a Spanish satellite, that will eventually serve 180 Iberoamerican universities and Ministries of Education. Key criteria for success are suggested. Kempf also includes supplemental material that describes the pilot program that will begin in May 1995. This tele-seminar is a cooperative venture of 8 institutions in 6 different countries: Argentina, Chile, Colombia, Honduras, Mexico, and Spain.

Leaving the Western Hemisphere we travel to the United Kingdom for two papers. In the first Tearle and Davis (University of Exeter) explain their work in developing multimedia resources (published on laserdisc) relevant to preservice teacher education. They explore the interesting possibilities of using such materials internationally—how transferable is the context of the UK classroom? Are some things universal? In the second paper Robinson (Cambridge University) argues for the place of change theory in the technology education of teachers. He notes four major factors that influence student teacher computer use and advocates teaching our students how to cope with these.

Moving across Europe, Paprzycki (University of Texas, Permian Basin), Vidakovic (North Carolina State University), and Ubermanowicz (Adam Mickiewicz University) compare the attitudes of Polish preservice teachers with those of students at three US universities. Factors considered were age, gender, school attended, as well as computer attitudes. Continuing eastward Bouniaev (Southern Utah University & Moscow Pedagogical State University) explores training Russian teachers to use information technologies in their mathematics teaching. He gives us a historical perspective as well as a current status report. In both papers the authors note the difficulties during these transitional times and their impact on teacher education.

The following three papers concern China, two on the mainland and one on Taiwan. In the first, Hunt (California State University, Fresno) describes her visit to educational institutions in China, providing background information as well as the current status of teacher education and technology. Bao (Shippensburg University) relates the development of China's first computer managed instruction and administrative software; the major characteristics of the software; how it is being disseminated; and new challenges for teacher educators to meet. Liao (National Hsinchu Teachers College, Taiwan) reports research on the effects of different cultural backgrounds on preservice teachers attitudes toward computers. His study compares the attitudes of student in the US Southwest and those in Taiwan.

From China we journey to the subcontinent of India where Srirengan (Technical Teachers Training Institute) describes trends in computer education in Indian schools. He provides an excellent overview of the work of a number of different training facilities and their use of technology. This includes the development as well as the delivery of technology materials.

Not all journeys can be mapped on a globe. Some are marked in more illusive ways. The final two papers deal with gender inequities still present in classrooms. Hutchinson and Kung (University of Wisconsin Stevens Point) looks at technology and problem solving activities in mathematics that can facilitate more equitable approaches. In a three week summer workshop fifteen elementary teachers explored using Lego Logo, problem solving, and gender issues in mathematics. Barber-Freeman (Mississippi State University) quotes a number of research studies that point to gender inequities and suggests that these will not be corrected until we identify and examine them publicly.

At this point we have come full circle, in that each culture carries baggage related to the way men should be treated versus the way women should be treated. As we are travelling around the world, the world is spinning rapidly toward the next century. Technology will help us get "up to speed," but we need to leave some baggage behind us. Several articles have addressed the need for us to be change agents. For a fully optimized multicultural global society we need to discard the ideas and beliefs that hold people down and cherish and enrich the beliefs and ideas that help us soar.

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Empowerment: Media Literacy Through the Precepts of a Global Multicultural Curriculum

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In this age of electronic learning, as advances in technology make possible global mass communication, a new literacy or new "illiteracy" as it has also been called (Aronowitz as cited in Giroux,1988) is emerging. This phenomenon promises to challenge the very foundations of our current social, political, educational, and cultural value systems.

In discussing the implications of this harbinger of twenty-first century culture, I have chosen an analytical approach which encompasses various critical pedagogical theorists as well as other writers who are able to shed light on the global impact of this media phenomenon.

> No longer is it enough just to read and write. In a world where information comes in many forms-text, audio, graphic, video- and where the amount of information is increasing at exponentially staggering rates, the literacy skills of the last twenty centuries will not take our students into the next one (Hill, 1992, p.28).

As an elementary school teacher of twenty-three years, I have seen some of the effects of the information technologies: television viewing, video game playing, advertising, and movies, on student's ability to think creatively, to write metaphorically, to access higher level cognitive reasoning skills and to discern reality from fantasy. Through the years, mass media and popular culture have managed to create a breed of heroes and mythical characters who have supplanted our literary folkloric traditions.

In this paper, I will first address some of the more obvious media concerns which contribute toward what has been called the "industrialization of the mind" (Giroux, 1988). I will concentrate on current research which shows how some media messages translate into racial, ethnic and gender stereotypes in the form of a hidden agenda which, when deconstructed through critical analysis, implicitly contain notions of power and control. This hidden agenda is what school children must be made aware of through teacher education and through various curriculum techniques which stress media literacy.

One technique which lends itself extremely well to this type of deconstruction is multicultural education on a global scale as proposed by such theorists as James Lynch and Sonia Nieto. The origins of multicultural education stem from humanitarian concerns and values which were a direct outgrowth of the civil rights movement and which lend themselves to teachings about hidden messages in the media. Values such as empathy, cooperation among peoples, appreciation for each other's differences as well as similarities, communication across cultures without prejudice, environmental concerns, peace education and a non-ethnocentric view of one's world are emphasized in this curriculum approach (Lynch, 1989).

It is my contention that as teachers begin to understand the impact of this media phenomenon, they will be in a better position to affect student attitudes and behavior. I will demonstrate how, through the use of teacher empowerment techniques and through various current curriculum strategies, schools are major players in this age of information technologies. Teacher education courses and curriculum strategies need to deal directly with multimedia messages, rather than to ignore the pervasiveness of mass media and its impact on our notions of culture.

Finally, I will address future trends within the industry of mass communications, and how this emerging world of electronic messages has the potential to transform cultural values and belief systems beyond our wildest dreams.

Theoretical Perspectives

Hans Enzenberger has claimed that the electronic media has become the major force in what he calls the industrialization of the mind.

> The mind industry's main business and concern is not to sell its product, it is to 'sell' the existing order-to perpetuate the pattern of man's domination by man, no matter who runs the society, and by whatever means. Its main task is to expand and train our consciousness, in order to exploit it.
> (Enzenberger as cited in Giroux, 1988, p. 79)

According to Giroux (1988), the development of technology and science, constructed according to the laws of capitalist rationality, has ushered in forms of domination and control that appear to thwart rather than extend the possibilities of human emancipation. Giroux, in his critical analysis of our multimedia society contends that historically, technologies have developed as a result of the dominant ideology and existing social formations. If one follows this line of reasoning, we see the possibility that electronic media and advancing technologies are merely vehicles through which the dominant culture maintains itself.

This type of control has also been referred to as "ideological hegemony," a form of control that not only manipulates consciousness but also saturates the daily routines and practices that guide everyday behavior (Giroux,1988). The impact of this phenomenon on our educational institutions has implications which are just beginning to be addressed. Giroux also contends that the distinction between visual media technology and print technology is of utmost importance.

> Media technology, through visual messages, has the power to influence people through manipulation and social control. Unlike the visual media, the print culture, books, magazines, newspapers, signs, etc. allows the viewer to 'freeze' information so that they might stop to reflect on what has been written... It is possible with the written word to assess more rigorously the validity and truth value of an argument. Print technology itself retains a check on the overly blatant manipulation of the written message. (p.81)

The passive modes of information processing in television viewing is another area of concern. Researchers describe such factors as:

> the fragmentation of time segments and visual units; television's lack of recursiveness, which precludes the revision process inherent in reading and writing; and the holistic manner in which children perceive television images as opposed to the linear, analytic and synthetic patterns of reading and writing.
> (Postman as cited in Lazere, 1987, p. 411-412)

This research, although in its preliminary stage, supports the view that mass media contains messages, whether overt or covert, which directly affect core value systems and belief structures. Claus Muller terms this phenomenon "restricted linguistic codes" within the cognitive operations in lower social classes as compared to the more "elaborated codes" in middle and upper classes (Muller as cited in Lazere, 1987). This sociolinguistic tradition discusses the deficiencies in media as students access analytic and synthetic reasoning and higher cognitive levels of thought.

Perhaps one of the most noticeable effects of this media blitz shows up within the classroom setting as students demonstrate a decreased ability to imagine. Lazere discusses how the media creates the potential for inhibiting people from being able to imagine any social order different from the established one. He contends that with television and movie viewing,

> ...present reality is concrete and immediate, alternatives abstract and distant; ability to understand an alternative is even further obstructed by lack of the sustained attention span necessary for analytic reasoning, of the capacity to imagine beyond the actual to the hypothetical, and of a sense of irony necessary if the social conditioning that endorses the status quo is to be effectively called into question.
> (Lazere, 1987, p. 413)

This is further demonstrated in the research of Postman (as cited in Lazere,1987) who suggests that students "turn off" when a lesson or lecture takes more than eight to ten minutes. He feels that TV conditioning leads to the expectation that there will be a new point of view or focus of interest or even subject matter every few minutes.

> Scores on reading tests are in decline. But even more important, writing, the clearest demonstration of the power of analytical and sequential thinking, seems increasingly to be an alien form to many of our young, even to those who may be regarded as extremely intelligent. Moreover, it has been observed that oral expression has not improved as writing skills have fallen off. (p. 422)

Postman (as cited in Lazere,1987) also comments on how the "hidden curriculum" contained within all of electronic media forms; TV, radio, audio tape, the photograph, film—each in its own way lends support to the undermining of traditional patterns of thought and response.

> Taken together, their 'hidden curriculum' conspires against almost all of the assumptions on which the slowly disseminated, logically ordered and cognitively processed world is based. In an environment in which nonlinguistic information is moved at the speed of light, in non hierarchical patterns and vast, probably unassimilable quantities, the world and all it stands for must lose prestige, power, and rel-

evance. (p. 423)

One of the final concepts which I would like to address, is that of "cultural imperialism" as discussed by Jeremy Tunstall (as cited in Lazere, 1987). The cultural imperialism thesis claims that authentic, traditional and local culture in many parts of the world is being battered out of existence by the indiscriminate dumping of large quantities of slick commercial and media products, mainly from the United States. According to Tunstall (1987), the debate about cultural imperialism and authentic culture, or traditional cultures, is reminiscent of, and related to, another debate about mass society, mass culture, and indeed the mass media. It is precisely the unpopular characteristics of much authentic culture that make the imported media culture so popular by contrast.

Through the dissemination of icons of material wealth, power, beauty and consumerism, certain forms of cultural identity are at risk. Moreover, cultural imperialism serves to camouflage the hidden messages contained within each instance of racial, ethnic and gender stereotyping.

Curriculum Strategies for Empowerment

After reviewing various critical theorists, and their views concerning media impact upon notions of culture throughout the world, I will discuss how some pedagogists address this issue through various curriculum strategies within classroom settings. Beginning with Lazere, (1987) who represents one extreme position on this subject,

> the goal of a communications system in a democratic society would be to maximize freedom of political and cultural expression, public participation and dialogue and debate among a full range of ideological viewpoints.... The model for such a system would have multi-channeled, multi-ideological national public communications networks, supplemented by a diversity of nonprofit media financed by local communities, universities and school systems, worker and consumer cooperatives, trade unions, and other interest groups. (p.555)

In contrast to their present monopoly on mass communication, this system would curb the influence of the rich in politics, media and culture. Lazere (1987) proposes examples of how to make use of the media within classroom settings, and expresses one innovative pedagogical practice which falls into the category of "cultural activism." These innovative techniques contain the following curriculum possibilities, if implemented by instructors who have had training in the theoretical basis for each technique:

1. deconstruction of subliminal messages and techniques of persuasion and propaganda, as seen in commercial advertising
2. studies of news broadcasts as seen from various political and cultural perspectives
3. studies on how sports, popular music, and mass-mediated religion contain specific rhetorical viewpoints on the role of class, and sexual and racial divisions
4. studies on the psychological effects of television and film violence
5. dramatic scripts or scenarios written by students themselves, dealing with familiar TV shows and films with differing political viewpoints
6. direct student involvement in media groups concerned with investigating media-related portrayals of sex and race bias in hiring and programming. (p. 556-558)

One curriculum technique which has the potential to address this hidden curriculum contained within media messages, is multicultural education on a global scale. As mentioned earlier, multicultural education was a direct outgrowth of the civil rights movement as a response to inequality in education based on racism, ethnocentrism, and language discrimination (Nieto, 1992).

With the teachings inherent in global multicultural education, we can begin to see ways to deconstruct overt or covert messages in the media which threaten our cultural values. This approach to multicultural education lends itself to the cultural activist view which stresses teacher and student empowerment. Concepts within the multicultural curriculum such as a concern for humanity, an awareness of the environment, peace education, an appreciation for cultural diversity, polylingualism, the development of cognitive abilities which lead to higher order thinking, a non-ethnocentric view of one's world, and the value of multiple perspectives directly address the negative effects of the mass media phenomenon.

According to Nieto, by expanding the definition of American, and by creating a variety of means by which self-identity is enhanced for all Americans, students and others facing the dilemma of fitting into a multicultural society would no longer face discrimination and ethnocentrism (Nieto, 1992).

David Lynch (1989) states that the basic ethic of multicultural education and the human values which draw upon it are beginning to be seen as applicable to all peoples everywhere. Implicit in the content of multicultural education are values stressing those things that unite humanity through similarities and commonalties, as well as through those things that enhance cultural diversity and ethnic identity. By using the basic structures and values implicit within multicultural education, deconstruction of media messages can begin to occur on a global scale. Perhaps this would be in the guise of global multicultural education, but none the less an inroad has inadvertently become available.

Finally, another curriculum technique which is currently emerging and which serves to empower, is media literacy itself. The following examples are taken from articles and books which I have been collecting over the past few years. I will not be able to list all of the sources in this paper because of their extensiveness. Once I began connecting with computer data bases, such as the one at Syracuse University over the ERIC Search network, and with TAG, (technology advocacy group) composed of University of New Mexico professors, parents, students, Albuquerque Public School teachers and business people here in New Mexico; I realized how important this area of curriculum development was for educators at all levels. I also realized how timely this topic had become.

Bary Duncan, president of the Association for Media Literacy, based in Toronto, pioneered the most extensive media literacy venture so far in North America (Daviss, 1992). Toronto's post-elementary public school students have set aside part of their English classes each year to analyze the structure of, and hidden values communicated by television programs. They begin to deconstruct what they see as they understand the medium's technical conventions. They realize how they are victims of corporate mythmaking and commercial value systems. Finally, students learn first hand how television can structure the versions of reality that it presents. In shooting, arranging, and editing their own productions, children come to know how television structures the stories it presents by making their own staging and editing choices.

One situation which has managed to empower teachers is seen in the Los Angeles Film Teacher's Association (LAFTA), a 600 member non-profit organization founded to encourage teachers to use audio-visual media as classroom teaching and learning tools. Their focus has broadened in recent years to include the television industries' responsibility toward children in terms of cultural values portrayed in the medium of television. This organization teaches students to "read" television and film and to be critical of it, the way they would be of books. " We need to help students be wise consumers of the media explosion, and LAFTA is committed to this goal" (Daviss, 1992).

The Media Literacy Institute (Ontario, Canada) is a teacher training program that promotes media education in the United States. In 1989, they defined media literacy as follows: "Media literacy is the ability to decode, analyze, evaluate and produce communication in a variety of forms." They have developed a series of techniques which teach concepts of:

> ...reality vs. mediated information, questioning of the economic basis of the media industries place in the overall economy, the phenomenon of derivement of heightened pleasure experiences through the media, and use of creative self-expression through direct participation in classroom media experiences. (Leveranz, 1992)

Conclusion

As mentioned earlier, the advancing information technologies have the potential to alter our view of reality as we know it. One such technology which is on the forefront of the communications industry is virtual reality (VR). The revolutionary technology of computer-generated artificial worlds promises and threatens to transform business and society (Rheingold, 1991).

Corlis, in *Time* states that:

> Movies and television are a passive experience, while VR games are interactive. The more active you are, the more you can enter into them.... Players become self-empowered junkies while the merchants get rich. VR can also become a socializing medium by getting the kids out of the house with a new gimmick.... There are worlds to explore giving you the sense that you are actually there— a sense of being weightless, and heedless, in that mysterious space between your ears. (Corliss, 1993, p. 82)

As an educator, I am particularly fascinated with the revolution in mass communications, for it has such astounding implications. Each day we are getting closer to technological breakthroughs such as the artificial worlds of virtual reality, which propose to alter our notion of culture as we now experience it.

It is crucial that teachers be made aware of these rapidly advancing technologies, and that they begin to take an active role in curriculum development. This active participation will serve to empower the teachers, along with their students so that they are not lead blindly down the path of apathy, numbness and desensitization. We as educators have a responsibility to involve ourselves with this mass media phenomenon, and to use it for the development of human growth and potential, for capturing and promoting sensitivity and understanding between diverse cultures and ethnic groups, and for the betterment of humanity.

What better way to bring media literacy into the age of information technologies but through school curriculum techniques which serve to empower as well as to offer sensitive explorations of our diverse cultural heritage.

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Computer Use in an Elementary Multicultural Classroom

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How teachers manage, supplement, and use classroom computers greatly determines what and how children learn with technology. Academic and personal success in the information age largely depends on the creation of supportive learning and thinking environments wherein computers serve as an information and learning tool. Unfortunately, though information on computer hardware and software abounds, textbooks "say a great deal less about how to teach effectively with computers" (Ryba & Anderson, 1993, p. 11). As minority children become a larger portion of the student population, the need to understand how to effectively use computers with these children becomes imperative. Only through such understanding can educators adequately prepare culturally diverse children for success in the academic world today and in the technological world they will inherit.

Assertions and Research Questions

This paper presents findings from an observational study that explored how an effective teacher uses computers in a culturally diverse elementary classroom. The study discussed here is part of an ongoing investigation of the use of computers in multicultural classrooms. Given the educational urgency for equitable and culturally responsive learning environments, the study has significance for teacher education and teacher training by providing insight on computer use within a culturally diverse setting. The case-study approach used in collecting data provides an in-depth understanding through direct observation of social interactions, classroom activities, computer use, and teacher and student interactions. However, the results must be interpreted within the context of a single classroom.

Four basic assertions underlie the study. First, computers are not culture-free. Like any other human artifact, computers are an expression of the people and culture that created them. Consequently, the computer culture and the native culture of many students in our classrooms are sometimes at variance. Second, equitable access to computers means that every child receives what he or she *needs* to learn and succeed. Because children differ in their needs, equitable access to educational computing means access to the same *type* and *quality* of software, hardware, and learning activities, but not necessarily to *identical* software, hardware, and activities. Third, across cultural groups there are differences in learning style preferences. Since culture influences how people organize and experience reality, as well as how they think and learn about the world, children's native culture also influences how they prefer to learn. Studies on learning and cognitive styles suggest that groups differ from each other in their learning (Anderson, 1988; Dunn, Gemake, Jalali, & Zenhausern, 1990; Huitt, 1988; Jacobs, 1990; Ramirez & Castañeda, 1974; Rhodes, 1990). However, these group preferences are not determinants for individuals because within groups there is individual variability. Fourth, teaching that supports students' learning and cultural preferences improves academic achievement. Culturally responsive education incorporates some features of the child's natal culture into the curriculum, teaching methods and instructional materials

(Au & Kawakami, 1991). For example, a curriculum integrating familiar patterns of storytelling for native Hawaiian children helped to improve these children's reading scores (Au & Jordan, 1980).

Based on these assertions, the study addressed four research questions:

1. How does an effective teacher of linguistically and culturally diverse students manage classroom computing?
2. Which learning styles are supported by the computer management strategies and software used by an effective teacher?
3. How do the computer management strategies of an effective teacher accommodate for cultural differences?
4. How does an effective teacher provide equitable access to computers across gender and ethnicity?

Sample and Procedure

The participating school, located in a large Southwest city, has a sixty percent minority student population. The school has a computer lab, classroom computers, and several CD-ROM computers on carts for classroom use, all of which re acquired through outside funding. The school principal identified the teacher who participated in this study as an effective teacher of minority culture children. This teacher, a white female of French Canadian descent, received state recognition for outstanding teaching and served as a mentor for student teachers. She had eight years of teaching experience and had used computers for the last four years. She had taken six credit hours in educational computing and earned a Masters degree in Multicultural Education. Her multigrade self-contained classroom had twenty five children in grades I, II, and III. Most children came from low to low-middle class families. Class composition consisted of fifteen Anglo children, eight Mexican Americans, one Chinese American, and one African American child.

Over a sixteen week period, I videotaped students two hours per week as they used the classroom computers. In addition, I interviewed ten students who were representative of the ethnic, racial, linguistic, and cultural diversity in the classroom. Those children interviewed were native speakers of English, Spanish, or Mandarin. Additional data came from a teacher interview, direct observations, and informal conversations with the teacher and students. Triangulation of the three data sources—student interviews, teacher interview, and videotaped computer use—provided a more complete picture of classroom reality and corroborated this researcher's observations with teacher and student perceptions. A video observation form developed for this study focused on a) computer seating arrangement, b) individual and group computer use, c) type of software applications used, d) teacher and student task delineation, and e) teacher and student mobility. A second trained observer viewed the videotapes separately using the observation form to corroborate the researcher's observations and to provide feedback for revising and improving the form for ongoing research.

Findings

Classroom Computer Management

Management of computer use included flexible seating at the computers. Seating was adaptable to students' needs and learning activities. Children could add or remove chairs as needed, stand behind children at the computer, or stop briefly to observe or offer comments on the work in progress. Depending upon the task, children's computer skills, and student or teacher preference, children worked individually, in pairs, in larger groups, or with the teacher. Partners were either self-selected or teacher-assigned. Although children generally self-selected same-sex partners, this was the only observed factor demarcating groups. Nevertheless, children talked with and observed opposite gender classmates at the computer and occasionally joined them for a moment.

The two classroom computers, an Apple IIe and a Mac LCII, were located on two tables set in a reversed-L configuration near an exit door. The computers were primarily for student use rather than teacher productivity. A dot matrix printer also rested on one of these tables. One computer's monitor was clearly visible to anyone who stood or sat directly before the monitor, but essentially unobservable to others in the room. The second computer afforded less privacy since it was located in a high-traffic area and its monitor was visible to anyone passing by or standing nearby. During the interview, the teacher indicated she selected this location for logistical reason, there was less dust in this area and it was close to other students in case children needed help. The computers were in use throughout the day except during whole class activities and scheduled breaks, such as lunch and recess.

The classroom was an active and noisy place. Often several simultaneous activities occurred in separate areas of the room. The teacher circulated among groups monitoring their progress, providing any needed assistance, and intervening as necessary. The teacher also gave students responsibility for monitoring themselves and for working together. She reported that she taught social skills for cooperation, problem-solving, and consensus-building through teachable moments and teacher modeling of acceptable behavior. Older students who had been with her in previous years also modeled acceptable behaviors. In one observation, three decided by voting which graphics to use in a slide presentation. This behavior was spontaneous and unsupervised by adults. Although clearly some students were more domineering in their computer use and attempted to control the mouse, keyboard, or computer microphone, there were no observed instances of physical aggression or prolonged arguments. Students largely resolved conflicts without adult intervention.

The teacher had high expectations for all students. During the interview, the teacher stated there are two class rules. The first rule requires that students share and help each other. The second rule requires that all students produce a product at the computer because, as the teacher explained, "creative people are producers." When questioned about their computer activities, students reported that

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they created pictures, wrote reports, produced cards, made slide shows, and wrote books, stories, poems, and newsletters. Thus all children engaged in creating a variety of relevant and authentic products. For example, as part of a thematic unit, the classroom became a shopping mall with a host of small shops. Among these was a card shop where the students generated Valentine's Day cards that they sold to other students and teachers. All children, on a rotating basis, wrote the class news, though they choose their topics.

Although this teacher expected students to produce, she believed that children also need time to play. Thus the researcher observed an African American first grade boy playing with *Kids Pix*. When I questioned him about what he was making, he responded "just doin' stuff." He seemed to engage in the playful discovery of program capabilities and options.

The teacher also helped students assess their progress by using the portfolio assessment program *Grady Profile* and through directive questioning. For example, after a second grade Mexican American girl finished recording herself on the computer reading her own manuscript, the teacher and student looked at the list of reading skills. As they proceeded down the list, the teacher asked questions such as "Do you think you read the story with expression? Do you think you need to do it better?"

Learning Styles

The management strategies and software used supported a variety of learning styles representative of the learning preferences of diverse cultural groups. Children worked alone or with others depending on personal preference and the nature of the task. In this way the teacher supported field sensitivity and field independence. Children could explore computer capabilities through self-discovery or learn the step-by-step program procedures from the teacher and their peers. Both the holistic and the analytical learner benefited from this flexibility. Software provided animated graphics, sound input and output, and visual text. Thus the programs met the needs of visual and auditory learners. Keyboarding and use of the mouse provided for the kinesthetic learner, as did physical mobility which allowed students to move to different areas of the room. Children also seemed comfortable in asking to have their needs met. For example, one second grade Anglo boy, during independent reading time, asked the teacher and me if we could help him find a "dark corner" for him to sit and read. Giving students choices allowed them the opportunity to engage in decision making, and to select activities that met their needs and interests.

Cultural Differences

The teacher provided for cultural and individual differences by supporting a variety of learning styles, giving children options, and encouraging students to support and respect each other. The literature on learning preferences of African American and Mexican American children suggests that they tend to prefer working with others and generally value cooperation and social interrelationships. They also seem to prefer holistic learning. As indicated above, this classroom supported these preferences. Moreover, the expectation that children share and help each other fostered an environment of mutual respect and acceptance. Since the teacher expected all students to produce, they saw each other as productive and contributing members of the class, regardless of gender, race or ethnicity. For example, the peer-recognized classroom computer expert was a third grade Mexican American female. Five of the students interviewed named her as one person they went to for help. Three children mentioned asking help from the Chinese American boy.

Equitable Access

Peer and adult help increased equitable access to the computer, especially for limited English proficient children. The teacher modeled computer use and provided encouragement, positive reinforcement, and suggestions to students at the computer. All children had a teacher-assigned *study buddy* selected on the basis of the teacher's observations and knowledge of the children's learning styles and personal compatibility. Study buddies were from different grade levels so that the older child served as a model. In general, children interacted and worked with everyone in the class. When asked whom she worked with at the computer, one child extended her arms and exclaimed "Everybody!" Students indicated they sought computer help from their study buddy, other classmates, the perceived peer computer expert and anyone in their vicinity who might know, including adult classroom visitors. These student responses reflect the teacher's desire to foster interdependence and cooperation.

All students, independent of their language ability, gender, or ethnicity, spent comparable amounts of time at the computer, worked on similar activities, and had access to the same software. According to the teacher, which students used the computer depended upon who needed to do something. Students freely requested the computer when they felt the need, were ready to edit their writing, or wanted to add graphic illustrations. Although some activities were teacher-assigned, such as the class news, other activities were self-selected, such as math games and the reading program *Arthur's Teacher Troubles*. Thus student motivation and interest were factors in computer access. At the same time, to ensure that all students used the computer, the teacher reminded slower students that they needed to edit their stories on the computer or continue work on an existing computer project.

In addition, all children took turns on a rotating basis writing the class news. Children self-selected their news topic. In addition, eight of the ten children indicated during the interviews that they did not mind having others watch what they did at the computer because they themselves were interested in what others did. They also said that by watching others at the computer they got ideas about things that they would like to try. Thus children not only shared by working in small groups, but also learned from observing each other.

Although children had equal access to the technology, their access was inequitable in that all students had access to the *same* hardware and software. Given the assertion that equity is based on meeting individual needs, then those children with limited English proficiency were at a disadvantage because their access was limited to software designed for English proficient children. These children's need for sheltered English materials, native language materials, or materials specifically designed for English as a second language learners went unmet. However, the teacher compensated for the inequality in software by providing other types of support, such as study buddies and teacher help. The teacher stated that software should help students become independent and should focus on creative expression rather than the mechanics of writing. This belief supports the language development of minority language children by emphasizing content rather than grammar and the mechanics of writing. To improve writing skills, the teacher followed the writing process with her students: brainstorming, writing, conferencing, rewriting and editing. In short, the teacher's beliefs and instructional strategies compensated for the software inequality.

Discussion

This experienced and highly effective teacher saw her role as that of a facilitator. She encouraged students to develop responsibility for their own learning and social behavior. She also fostered interdependence, respect, and cooperation among students. Children perceived everyone, even outsiders, as helpful resources. Thus they sought help from a range of individuals and generally enjoyed working together. The observations and student interviews suggest that they shared freely and willingly with each other. Students knew that the teacher held high expectations for them and that she expected them to be productive. The computer management strategies and software used supported a variety of learning preferences and, indirectly, cultural learning preferences. By consciously trying to meet individual differences, this teacher supported cultural differences as well. Furthermore, by creating an environment of mutual respect, acceptance, sharing, and cooperation, this teacher created a classroom that valued and supported diversity. This classroom atmosphere of high expectations, respect, and collaboration, provided a strong foundation for equitable access to computers. Assigned task rotation, student self-selection of activities, plus teacher-assigned activities ensured that all students had comparable experiences and opportunities to work at the computer. In addition, a network of peers and adults provided needed computer support for slower learners and those with limited English proficiency.

Implications and Further Questions

Although the current study involved observations in only one classroom and, therefore, has limited generalizability; it does reveal how one effective teacher manages and uses computers in a culturally diverse classroom. These findings also parallel previous findings on effective teaching (Au & Kawakami, 1991; Carrasco, Vera, & Cazden, 1981; McCollum, 1989; Vogt, Jordan, & Tharp, 1987). Such studies indicate that effective instruction entails flexibility in classroom arrangement, respects and incorporates features of the children's native culture, and supports cultural and individual learning preferences. As in Luis Moll's (1988) study on effective teachers' social mediations, the current study found that this teacher engaged students in meaningful learning, offered flexible instruction, gave students options and autonomy, and held high student expectations. The similarity in findings between the current study and previous studies suggests that effective computer management and instructional computer use ultimately reflects good teaching practices.

The results from this study lead to additional questions. Do the computer management and instructional strategies observed in this multiage multicultural classroom differ significantly from those of other teachers? How do the computer management and instructional strategies differ across grade levels? Do the effectiveness of management and instructional strategies differ according to degree of students' acculturation into the majority culture? How much teacher technology training and what type of teacher training will result in effective computer use? How do teachers use computers with minority children to promote higher level thinking skills? As the number of computers in low socioeconomic and minority schools slowly increases, the answers to these questions become crucial for effective and equitable teaching.

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Multimedia Multicultural Instruction: Exploring Diversity with a Non-Diverse Student Population

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One of the current challenges facing teacher education programs is preparing preservice teachers to integrate technology into instruction. The typical lack of technology integration in the teacher education programs has been cited as a major impediment to technology use for beginning teachers ("Schools of Education", 1991). A common rationale for integrating technology into teacher education courses is that if future teachers are to effectively utilize technology into their teaching, they must have models for doing so in their teacher preparation programs (U.S. Congress, 1988; Wetzel, 1993). In addition, when students experience the contribution of technology to their own learning, they may be more motivated to use it to facilitate learning in their future classrooms (Gabel & Boone, 1993).

Another major challenge facing teacher education programs is preparing prospective teachers to educate an increasingly diverse student population (Larke, 1990). While the student population is becoming more diverse, the population of teachers is becoming less diverse (Hodgkinson, 1989; National Education Association, 1987). It has been estimated that by the year 2000, the proportion of ethnic minorities in the school-age population will increase to 40% (Hodgkinson, 1989; Villegas, 1991). In addition, the percentage of white, female, and middle-class preservice teachers from rural or suburban environments has also been increasing (Fuller, 1994). Often these prospective teachers have had little exposure to people different from themselves and get little contact with minorities in the colleges of education they attend (Fuller, 1994). These trends demand that teacher education programs take measures to enable their graduates to work effectively with an increasingly diverse school population.

Method

In an effort to address these concerns, I undertook a project that used computer software, videotape, videodiscs, and print media in an undergraduate Educational Psychology course in order to enhance students' understanding of multicultural issues in education and to model the integration of technology into instruction. The School of Education had opted to integrate technology into methods courses rather than teach it in a separate course. Being the sole faculty member in Educational Technology and also being responsible for teaching a non-technology oriented course, it seemed fitting that I take the initiative to model the integration of technology in this course.

The project was conducted at a relatively small private university with a student body that had a very small proportion of students from minority ethnic or racial groups. During the semester that this project was conducted, my section of Educational Psychology consisted of 32 undergraduate females. There were no males and no members of minority groups in the class. Noting the lack of diversity typically found in our preservice teachers and the resulting lack of opportunities to interact with members of a variety of cultural and ethnic groups, I chose multicultural education as the topic for a technology-integrated unit.

The unit was intended to provide experiences and information that could form the basis for increasing students' sensitivity to those from cultures different than their own and to help them understand the implications of such differences for teaching practices. The materials used in this project were:

1. *Dimensions in Multiculture:* A multimedia HyperCard stack providing information about diverse cultures which allows students to add commentary and create their own sequences of information.
2. *Decisions, Decisions—Prejudice:* A computerized simulation that creates an environment in which groups of students can learn and talk about prejudice and discrimination and explore the processes that underlie and perpetuate these phenomena.
3. *GTV—The American People: Fabric of a Nation:* Two laserdiscs and accompanying software that allow students to explore both the unity and diversity of American life and help them to appreciate the unique perspectives of different racial and ethnic groups.

The unit on multiculturalism took approximately four 75 minute class sessions to complete. Each of the multimedia presentations or activities was followed by a whole class discussion. The unit was introduced with the aid of the *Dimensions in Multiculture* program which was projected onto a large screen using an LCD projection panel. The first activity in this program asked students to create a definition of culture and then compare it to one from a dictionary. Then the students were asked to create a "concept map" or "word web" depicting their conception of culture. Rather than doing this activity on the computer, students did this in small groups using markers and large pieces of chart paper.

Next, a video segment from *GTV—The American People* called "Look Again" was shown to demonstrate the importance of knowing more about other cultures than just the commonly held stereotypes that we may believe about them. The video examined the diversity among people characterized as "Hispanic." It showed that such labels often obscure important individual differences within a culture. In addition, students were given a handout which was printed from the *Dimensions in Multiculture* program. This handout was a fictional ethnographic description containing many humorous, but nevertheless inaccurate statements about the "Caucasian culture." This essay also demonstrated the importance of going beyond surface level understandings of other cultures.

The next topic concerned two different ways of viewing American culture: as a "melting pot" or as a "tapestry." Students were shown another video segment from *GTV—The American People,* called "The Center Cannot Hold." The video examines how life in America has always been a balancing act between diversity and unity. Students were also given a handout provided in the *Decisions, Decisions—Prejudice* teacher's manual called "America: A World of Difference." This material came from a program developed by the Anti-Defamation League of B'nai Brith in 1985. It explained the historical origins of diversity in America and also discussed the "melting pot" versus "tapestry" perspectives of American culture.

Finally, we examined the topics of racism and prejudice. Students were shown a video (taped from an ABC newscast) about a program for teenagers designed to combat racism. This very moving video does an excellent job of showing the negative effects of racism from the point of view of high school students in Los Angeles. Students then participated in the Decisions, Decisions—Prejudice role-playing simulation in groups of four or five in the computer lab. Afterwards they completed a summary worksheet provided in the program's teacher's manual. Students were also given copies of several news articles describing controversies similar to the one presented in the computer program in attempt to show that the problem in the simulation was realistic.

Results

The effectiveness and impact of this unit was evaluated through analysis of students' responses to two questionnaires as well as informal observations of students during the course of these activities. The first questionnaire assessed students' feelings about various characteristics of potential future workplaces. It was administered both at the beginning and at the end of the semester. Students were first asked to rate their comfort with and interest in teaching at four different types of schools: a public school with a predominantly African American student body, a public school in a wealthy residential neighborhood, a public school in a predominantly Hispanic neighborhood, and a private school with an ethnically mixed, but predominantly wealthy student body. Results indicated that on the average, students felt quite comfortable with and interested in working in public and private schools with affluent student bodies. On a scale of 1 to 5 with 1 indicating the highest degree of comfort or interest, the means for these items ranged from 1.5 to 2.0. A lesser degree of comfort and interest was expressed for working in public, predominantly African American or Hispanic schools. The means for these items ranged from 2.9 to 3.6. There were no significant changes from the pre- to post-test in the students' attitudes toward working in any of the settings.

Students were also asked about the importance of various characteristics of schools to their choice of a future work setting. They rated 14 statements on a scale of 1 to 4, with 4 indicating the greatest degree of importance. Table 1 shows the means for these items for both the pre- and post-tests. It is interesting that the only item for which there was a significant difference between pre- and post-test ratings was the item stating that "it is important to have an ethnically diverse mix in my classroom" ($t = -2.66$, $p = .013$).

At the end of the semester, students were also asked to complete a questionnaire that requested feedback on several aspects of the multicultural unit. Students were asked if they had gained new understandings or knowledge about cultural diversity and if so, what did they learn or how did their thinking change. About 80% of the students stated that the unit did increase their understanding of cultural differences. The most frequent comments indicated that the unit increased students' awareness and appreciation of cultural differences; a phrase that was used several times was that it

Table 1.
Mean Item Ratings For Pre- and Post-Test

Items	Pre	Post
It is important that...		
my students' ethnic backgrounds are similar to my own	1.39	1.44
other teachers' ethnic background are similar to my own	1.54	1.74
my students' SES backgrounds are similar to my own	1.64	1.63
my class is socially and economically diverse	2.29	2.37
my class has an ethnically diverse mix	2.32	2.74
my class has a mixture of ability levels	2.32	2.67
my students speak English as their native language	2.57	2.67
my students are high achievers	2.61	2.33
my students are well behaved/ easily disciplined	2.68	2.41
my students are intrinsically motivated	2.79	2.52
the school has sufficient educational/ economic resources	3.04	3.15
the school has few security problems	3.25	3.33
the school building/neighborhood is physically safe	3.39	3.44
my students' parents are supportive	3.50	3.37

Note. Items were rated on the following scale: 1 = it doesn't matter, 2 = somewhat desirable, 3 = highly desirable, but not essential, 4 = absolutely essential.

"opened my eyes." Some students commented on their previous lack of exposure to cultural diversity. Comments included: "I always went to an all white school basically and I know it may not be like that when I begin to teach," "I have not been aware of the many different cultures around," "I was insensitive to the fact that all students have various backgrounds," and "I've been sheltered and I appreciate and welcome diversity now." Other comments indicated that the unit helped students empathize with people from other cultures or increased their awareness of points of view different than their own.

In addition, the unit seemed to help students understand the need for learning to deal with cultural differences in the classroom. One student stated that "I saw that diversity is going to be in all of our classrooms and we must learn how to deal with it." A special education major commented that "I realized that I need to accommodate for all students, not just ones with disabilities." Several students also commented that the unit helped them understand ways to incorporate differences into the classroom. Approaches for dealing with cultural differences mentioned by students included: "I learned that it is OK to acknowledge differences, but that the differences need to be viewed as strengths," "It taught me ... not to discriminate and how it is important to treat everyone as an individual... and that its important to keep them motivated," and "All students ... need the language and material presented to them in the way they understand."

Students were also asked about which activities in the unit were the most and least effective. Some students (10) thought that all the activities were effective. No single activity stood out as being particularly ineffective. The concept mapping activity was particularly popular (cited by 12 students). Also, the videos (particularly the one about the program for Los Angeles teenagers aimed at combatting racism) were thought to be especially effective by several (5) students. The computer simulation got mixed reviews; it was the most frequently mentioned effective activity (by 13 students), but was also most often cited as an ineffective activity (by 8 other students).

Comments on the last question of the feedback instrument, which asked about the effectiveness of the different types of media used in the unit, provided some insight into why some materials were effective and how to improve the effectiveness of others. Students seemed to respond well to the use of a variety of different media (or at least it seemed help insure that the unit contained something to catch the interest of just about everyone). One student mentioned that all the media were effective because they provided "a variety of things which kept interests up." Another student said: "I thought that it was good to use many different types of materials because different people respond differently to each stimuli." Also, students seemed to think that the videos were effective because they "showed real schools and real life situations" which made them seem more meaningful or relevant. Reasons why the computer simulation was thought to be effective included: it allowed students to interact with each other, it made learning fun and interesting, it allowed them to be active in their learning, and it was different from the usual teaching methods. One student commented: "The computer software was the most effective for me because it was something different. I'm used to handouts & videos—the computer really catches my attention! Use it more!!"

One of the frequently mentioned reasons why the computer simulation was not effective was because some students did not like computers to begin with. For example, one student commented that: "I did not really enjoy the computer project. It lost my interest because I don't really enjoy computers... I did not think [it] was very effective, but people who like computers probably would have enjoyed it." One student even went as far as to suggest that this activity hampered her learning of the entire unit "because the computer turned me off automatically." Another student commented that she didn't like it, but that "it was good to see that such materials exist" and another said she didn't like it, but that it was "good to take a break from note taking for a day." Other reasons mentioned for why the computer activity was ineffective included: not enough time provided for completing the activity, the simulation didn't relate to reality, the computer programs were difficult to see when displayed with the overhead projector onto a screen, and the program took too long to come up on the screen.

Discussion

The primary goals of this project were to enhance students' understanding of multicultural issues in education and to model the integration of technology into instruction in an undergraduate Educational Psychology course. Since students were a homogeneous group who tended to lack experiences in relating to those from cultures different from their own, technology was used to provide experiences and information that could form a basis for increasing their sensitivity to individuals of other cultures and to help them understand the educational implications of such differences.

Students preferences regarding their future workplaces did not change over the course of the semester. They tended to be comfortable with and interested in working in public and private schools with affluent student bodies and less comfortable with and interested in working in public, predominantly African American or Hispanic schools. Also, with one exception, ratings of the importance of various characteristics of future workplaces did not change during the semester. The only item for which there was a significant difference between pre- and post-test ratings was one that referred to the importance of have an ethnically diverse mix in a classroom. Because there was no control group, it is not possible to conclude that the multicultural unit was responsible for this difference. However, it does suggest that the unit may have had some influence on students' attitudes toward cultural diversity. Students tended to value ethnic diversity more than they did at the beginning of the semester. Written feedback on the unit also indicated that students had gained a better understanding of cultural differences, with several students indicating that the unit "opened their eyes" to something that they had not experienced or considered previously.

Students seemed to respond well to the variety of media used in the unit and to appreciate a departure from traditional teaching methods such as lectures. The computer simulation was the most popular activity in the unit, followed by the concept mapping activity, and then the videos. However, the computer simulation was also the most frequently mentioned ineffective activity. Much to my surprise, negative attitudes towards computers seemed to interfere with some students' ability to profit from this exercise. Preparatory activities aimed at increasing students' level of comfort with computers may be necessary before asking students to learn from computer activities.

It is unlikely that a single unit would result in major changes in students' attitudes or skills with regard to multicultural issues or the use of technology in education. However, the project evaluation offered some evidence that at least students' awareness of and interest in these areas had increased. Repeated exposure and practical experience throughout the teacher education program seems necessary in order to adequately prepare prospective teachers to function effectively in these areas. Successful implementation in one course may provide motivation for other faculty to provide similar or related activities in their courses.

Finally, it was interesting for me to experience the process of integrating technology into a non-technology oriented course. I gained a better appreciation for the difficulties involved in conducting such a project. There were no readily accessible models for integrating technology in this course. The identification and selection of materials was difficult. Once they were obtained, it was not immediately apparent how they could be used together in a single unit. Field testing the materials separately during the semester prior to implementing the unit as a whole was helpful. This allowed me to identify problems and determine what modifications should be made in order to use the materials effectively. Developing the unit was time consuming. In addition, its implementation took more time than was usually devoted to this topic and thus other topics covered previously in the course had to be eliminated. Nevertheless, I felt the effort was worthwhile and plan to continue to refine its implementation in future semesters.

Credits

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Building Bridges: TESOL and Technology

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Technology is an area that permeates our lives; yet its potential for educational use has not yet been tapped — particularly as it relates to meeting the needs of second language learners. Hunt and Pritchard (1993) report that fewer than 25% of teachers currently teaching minority language students use technology in their teaching. The problem is not simply lack of access to computers because 60% of the teachers who have computers in their classrooms don't use them with language minority students. Further, among the 40% who do use technology with language minority students, these students are usually assigned only drill and practice programs, which may do them more harm than good (Hativa, 1988; Roblyer, 1989).

Knowledge of Teaching English to Speakers of Other Languages (TESOL) methods has become a necessity for all teachers because of the high proportions of students whose native language is other than English. Demographers have projected, for example, that by the year 2000, 80% of the student body in Texas, as well as other states, will be minority group members (SEDLETTER, 1991). Providing teachers with the integration of these two areas— technology and TESOL methods — is vital if teachers are to design learning that will provide success for all students. This paper describes the design, implementation, and formative evaluation of a course in the integration of technology with TESOL which we taught collaboratively during fall 1994 at New Mexico State University. We reasoned that a TESOL methods course, while helpful, would be more powerful if it included the use of technology. At the same time we felt teachers interested in working with minority language learners and bilingual students should learn ESL methodologies along with appropriate technology use. Therefore, we designed a six-unit block in which students would receive three semester credits in each of our specialization areas, TESOL and learning technologies.

Design

The course was designed to cover the methods of TESOL as well as related uses of technology as illustrated by the chart on the following page. The facilitators began by outlining topics for discussion in the methods part of the course and then linking those to related topics in technology. That is, as topics were identified in the methods part of the course, a relevant area of technology that could be used to enhance the teaching method was also demonstrated.

Assignments were developed collaboratively for the course as well as criteria for evaluating student work. Course requirements and percentage of grade were as follows: three mini-research reports (30%); bi-weekly logs on internships (20%); three technology projects (30%); and development and publication of a class book on ESL resources for teachers (20%). Criteria for grading each project included specific examples and point values. The following is an example from the video project:

The narrative you include with your video segment should include:

1. *the content of the video segment (e.g. , does it contain storybook segments, a dinner table scene, an action sequence?)*

2. *the procedures for implementation of the video-based activity in the classroom*
3. *possible variations/adaptations for different groups of learners*
4. *how the video activity can be used as a springboard for additional activities*
5. *how the video might fit into a given curriculum (i.e. what objectives could be met by video activity such as learning dialogue, story structure, vocabulary, and/or critical literacy?)*

Getting Started

During the initial part of the course an overview of factors that affect second language acquisition was provided. Discussed, for example, were the impact of motivation, attitude, age, the first language, the social context within the classroom and the political context within the community and society at large on the learning of a second language. This overview was initiated by dividing the class into groups and having them reminisce on both the positive and negative aspects of their prior language learning experiences. Personal experiences, as reported through their groups, then became data which were used to highlight the various factors that influence second language acquisition. One finding which emerged from group discussion was the relative high esteem in which the English language is held even in Spanish-speaking communities.

During this part of the class, students were expected to read widely in the literature related to language learning and their areas of interest in order to write their research reports. A library of articles and books was developed by the instructors and available in the room for check out on a weekly basis. Student essays were evaluated holistically based on the same writing scale used to evaluate our department's written master's exams.

Many of the teachers taking this class were new to technology. We needed to teach them basic computer skills as well as appropriate TESOL methods. In order to support students in thinking about language learning, while also feeling comfortable using computers, the technology component of the class began with two kinds of programs, those designed for children learning language; and those that provided significant nonverbal cues for communication. Using *KidWorks* (Davidson), *KidPix* (Broderbund), and several interactive CD-ROM storybooks including *Grandma and Me* , *Arthur's Teacher Troubles,* (Broderbund) and *Aesop's Fables* (Discus), students imagined themselves as beginning readers of English and reflected on the support these types of tools offered. They learned to create icons for *new* words in *KidWorks* and attempted to communicate their thoughts without words using paint programs.

In order to demonstrate nonverbal support for communication, we had hoped to get a variety of multimedia programs in languages which few of us knew. While the quantity of programs we obtained was not large, we were able to ask students to read an interactive multimedia story in Japanese and to study the beginning lessons in a language they didn't know using the *Rosetta Stone* (Fairfield Language Technologies), a multimedia tool for language German, French, Spanish, or Russian. Students also used *Transparent Language* (Transparent Language Inc.), a program which teaches language using context clues. The learner clicks on the unknown word and a text explanation appears in the person's native language. The program is now used as part of intermediate Spanish classes at NMSU.

Hypermedia was also introduced as a potentially valuable tool using HyperCard stacks developed for second language learners in California. By clicking on *hot text*, students can hear words in another language, see pictures, or receive additional textual information. During these exercises, the relatively new concept of *three-dimensional text* became a familiar idea. Finally, all students opened e-mail accounts on the university system and participated in additional dialog with the instructors using E-mail.

Logistics

We had expected a small enrollment, reasoning few teachers would want to commit to a six credit course that required attending class from 4:30-9:00 one night a week and an additional two hours a week in a related internship working with ESL students. Expecting twenty students or fewer, we finally cut enrollment at thirty-two students. The original design for the class called for us teaching both methods of ESL and technology applications together. However, we soon decided 32 people in a computer lab designed for 20 was a bit crowded. An introductory needs assessment indicated that about half the class taught adult ESL classes while the other half taught elementary, middle or high school. Therefore, after the first week, we redesigned the class to include a short total group session and

Table 1.
Integration of TESOL Methods and Technology

TESOL Methods	Technology
1. Factors impacting SLA and holistic orientation to TESOL, learner-centered curriculum	Introduction to new tools for language learning (sound, picture, text, video) Basics of computer use
2. Teaching language via content using scaffolding and integrating culture.	Technology support for sheltered English. Use of paint tools, writing tools, and hypertext.
3. Use of dialogue: drill, role-plays, inquiry, problem-solving, games, songs, and presentations.	Video for dialogue activities and taping role plays, presentation software, teacher tools for making instructional materials, spreadsheets, visual problem solving
4. Writing: writing process, group editing techniques, oral histories, journals, controlled composition, sentence combining, cloze, dictation, language experience	Desktop publishing (Bilingual Writing Center, Writing Center for Windows, Express Publisher, LinkWay) HyperCard Oral Histories
5. Reading: identifying multicultural literature, stories for children and adults for inquiry and writing, scaffolding for reading comprehension, reading logs, pre-reading activities	Exploration and evaluation of multimedia materials (CD-ROMS,ROMS,videodisc) English Express, Rosetta Stone, bilingual and multicultural stories
6. Alternative assessment techniques for ESL: portfolios (planning, implementation and evaluation process	Electronic Portfolios: writing, reading, recordings, drawings, Grady Portfolio

two pullout sessions, repeating the same lessons in the technology lab and classroom sections, but modifying them based on the age level our students taught. The students immediately appreciated the increased help available with smaller numbers, especially when learning to use computers.

Another logistics task was making sure everyone had a practicum site. By prior arrangement many of the students were assigned to teach conversational English classes at the community college which shares a campus with New Mexico State University. Teachers who were currently teaching in the public schools and had ESL students in their classes were supported in using their own classrooms for the practicum. Additional course content is described in the following sections.

Teaching Language Via Content

The course continued with a discussion of *sheltered English instruction* whereby language is taught via content. Many of the teachers in New Mexico and Southwest Texas have classes in which the majority of the children don't speak English as their native language. The importance of building on the experiences the student brings to the classroom was stressed again. In the language arts, for example, Hispanic children can be asked to share *cuentos* (which are a cultural tradition) or folktales, which can then be used as a springboard for discussion of story structures. Likewise, a science unit on plants could begin by asking children to share their knowledge of growing and harvesting crops because many of the students in the Southwest come from migrant farm worker families. This not only provides good pedagogy for building on what a student knows, but also validates their background knowledge and experiences in the classroom.

The use of scaffolding was also discussed as it relates to teaching language via content. The class discussed the many ways one could enhance a lesson in order to make it more comprehensible to students whose native language is not English. These included, for example, the use of charts, maps, diagrams, pictures, slides, posters, film, realia, facial expressions, gestures, and body movement, including Total Physical Response (Lessaw-Hurley, 1990), as a means for ensuring comprehension of the content which was being taught.

In the computer lab, students continued working with tools that provided pictorial support. One of our favorite programs became *Storybook Weaver* (MECC) which we had only in Spanish. Even for non-Spanish speakers the book creation program was an effective tool since each story could be created using pictorial backgrounds and objects. Clicking on an object gave the writer the necessary word to then *write* a story.

Writing as a Computer-assisted Process

During this part of the class, students engaged in their first technology project which involved learning to use computers to support the writing process. They were exposed to a variety of additional programs designed to support the writing process such as *Process Writer* (Scholastic). Since our education lab contains primarily K-12 writing software, we also took a field trip to the community college computer learning lab so that students could try a variety of programs geared toward adult learners of English. A model for using computers and writing in the ESL classroom (Butler-Pasco, 1993) was also shared. Within this model, all writing begins with communicative activities, often stimulated by technology-based interactions using telecommunications or visual databases. Evaluation for improvements in skills such as spelling and grammar is done during the later part of the writing process. Once students are aware of areas which need improvement, they can self-select appropriate software which they can use on their own. The basis of this model is that, while skill work may be necessary, it should emerge from each student's communicative writing.

Writing activities were also the focus of our next discussions in the TESOL methods section of the class. Publications, which are collaboratively produced by the class, were discussed as a highly motivating, purposeful activity which engages students in the writing process. The class knew that rather than a final, they were required to produce, as a class, an ESL Resource Book that would be useful to teachers. About half way through the class the collaborative writing, editing, and production of this book became a focus of energies and desktop publishing programs were taught in the computer lab.

Additional open-ended writing activities that were demonstrated were oral histories, language experience, journals, and reactions to literature. Community literature approaches in which students use *codes*, such as poetry or pictures, to compose stories that give voice to their inner selves were demonstrated and experienced. Additional structured writing activities were also described, such as, controlled composition and sentence combining and their usefulness for learning specific language patterns.

Video in the ESL Classroom

Dialogue was the topic for the next part of the course. Discussed were the various ways in which to initiate dialogue, as well as the important role which dialogue, as a form of social interaction, plays in the second language classroom. Particular attention was paid to the generation of dialogue through inquiry, or asking open-ended questions. Inquiry was then applied to the use of problem-posing (Wallerstein, 1987) in the classroom, a process which allows the learners to reflect critically on their personal circumstances and to take action which helps shape their lives in ways they desire.

Dialogue lead naturally into the second technology project, the use of video in the ESL classroom. We were realistic enough to know that many teachers do not have access to computers but can usually obtain VCR's. In many ways, this was one of the most successful components of the class. We brought in a variety of video segments from instructional or commercial programs and linked these to specific writing techniques. For example, students were shown just the beginning and then the end of an exciting adventure sequence and asked to fill in the middle. One activity involved half the students watching the movie without words, the other half seeing no pictures and hearing only words, and then both groups working together to recreate the movie segment. Ideas for making your own videos with ESL students were also discussed.

Students who used these video techniques in their classroom were excited about the effects. One teacher described a Russian girl who had barely spoken until he showed a segment of a documentary about her country. All of the students asked her many questions and she began to talk happily about her home country. Another teacher allowed the students to create their own video on the playground designed to demonstrate verbs— playing, running, swinging, sitting, etc. She remarked on the large increase in language students used as they were allowed to engage in the real world problem solving required.

Meanwhile in the computer lab, students were engaged in not only using writing software, but also learning a variety of useful microcomputer applications such as databases and spreadsheets, which make up the computer competencies we expect for all students. They learned to make a database of their students, send a *mailmerged* letter , and use a spreadsheet for keeping student grades. Problem solving using spreadsheets and graphing was also introduced as a high level thinking activity that didn't require extensive language. Students were enthusiastic about giving ESL students projects like comparing the price of meals at fast food restaurants in their neighborhood using a spreadsheet.

Critical Evaluation of Multicultural Media

The identification and use of authentic multicultural literature was the next topic. The use of literature as a springboard for additional activities such as writing, dialogue, and problem-posing (Wallerstein, 1987) was discussed. Scaffolding activities that aid comprehension of story structure were also demonstrated including story maps, character maps, Venn diagrams, and prediction charts.

This was an excellent opportunity to introduce the idea of visual literacy into the class. It was emphasized that information is not necessarily appropriate for use with students, just because it is provided via a movie, on a videodisc or CD-ROM , or introduced in a piece of software. Using the same multicultural evaluation checklist used for books (Ramsey, 1987), we required students to evaluate a variety of multimedia products, CD-ROMs, and videodisc programs in terms of their cultural sensitivity and quality. As students learned to use multimedia, they also suggested appropriate uses for it in the ESL classroom.

Alternative Assessment

Alternative, or authentic assessment (Pierce & O'Malley, 1992) was the last topic covered for the semester. We had modeled alternative assessment throughout the class through our assignment evaluation procedures which included holistic rating scales and the use of qualitative checklists. Many of the classroom activities also included self-assessment as when students evaluated their own writing for the ESL Resource book. Additional instruments to assess student progress were demonstrated including the use of electronic portfolios as well as checklists, observations, writing samples, reading logs, recorded readings, and learner diaries. The need to collaboratively (facilitator and students) design an implementation plan prior to or at the start of instruction was discussed, as well as the need for rigor and consistency with respect to data collection.

Formative Evaluation

Student feedback was solicited in the middle and at the end of the class using open-ended questionnaires. Students revealed that they liked the format and content of the course but felt too much time was spent on "housekeeping" and there were too many assignments. They also felt that, at times, the link between TESOL methods and technology use was not explicit enough. Many students indicated a positive change in their perception of the usefulness of technology for language learning. An example of this is a student's remark that "I now know technology can be used to teach, not just support " Students had mixed feelings about producing their own book. We worked to make it their book and not impose our ideas on the process. However, some students indicated that they wanted more direction. Finally, feedback suggested we may have tried to cover too many topics in too short a time.

From the instructors' point of view we shared the students' feelings that there needed to be more coordination between the two sections of the course. Our original design called for team teaching everything which would have facilitated this connection and we are considering limiting enrollment to support this approach. Our efforts in refining the class for next fall will involve designing projects that provide for deeper integration between language learning and technology use. This process will require giving up the need to cover as much material as we used to in our separate classes.

Was it worth it? From our students and our point of view it was an exciting, sometimes confusing, but always stimulating attempt to design learning appropriate for today's students and our future world.

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A Model for International Education and Cooperation

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The rapid development of computer technology and its introduction into the process of schooling has caused great concern among educational leaders, particularly in third world and developing countries. These educators fear that children in their countries, already at an educational disadvantage, will fall further behind because of lack of technology in their schools. Concerned leaders in several Latin American countries have addressed this concern by developing programs aimed at educating teachers for technological innovation. They see the introduction of technology to school children as a means of jump-starting their national economy and presenting their citizenry with a means of leaping into the twenty-first century. To support the training needs of teacher educators in developing countries, The International Center for Technology and Education at the University of Hartford has developed a Masters Degree program in Educational Computing and Technology. This program, started in 1990, to support a cadre of national tutors sponsored by Fundacion Omar Dengo of Costa Rica, has now expanded to include educators from several other developing nations including Venezuela and Peru and will include Taiwan during the coming year.

This paper describes the origins of this Masters Degree program. The roadblocks and impediments to such a program between international partners is chronicled along with the positive aspects of such cooperation for both international and regular students at the University of Hartford. Finally, the expansion to other centers is summarized.

Fundacion Omar Dengo

In 1986 Oscar Arias was running for election as president of Costa Rica. As part of his election platform, Arias promised to take steps to ensure that Costa Rican children think of themselves as belonging to the modern world and as citizens of a *developing* nation rather than as Third World outsiders. He planned to put this promise into action by bringing computing to all elementary schools in Costa Rica.

To begin this wide spread computerization of elementary schools, a call for proposals was initiated and interested corporations were invited to submit complete plans, not only to supply and maintain computer equipment but to determine the educational content, teacher preparation, and evaluation process. Because the company winning this contract would be responsible for the supply of over four thousand computers, there was intense interest and eventually fourteen large companies submitted bids.

The Programa Informatica Educativa, as the project came to be called, began in earnest when a bid from IBM was selected as the winning proposal. This bid was exceptional in a number of respects. It was striking in that a large proportion of effort was to be devoted to the advanced preparation and continual support of teachers. This support was to carry on for the life of the project. IBM's proposal was developed in consultation with Seymour Papert of MIT. Papert is an internationally known computer education pioneer and the developer of Logo. At Papert's suggestion, IBM proposed a plan that placed primacy on the role of teachers. The success of this program in Costa Rica can probably be attributed to the attention given to teachers, and this success has led to several other projects in Latin America.

Oscar Arias was quite aware that the innovative process he had initiated would need time to achieve the results he envisioned. To protect this and future projects against potential interference from bureaucracy and changes in government, Arias gathered a group of twenty-two Costa Rican professionals and created a private, nonprofit foundation, independent of government, to oversee the project. This foundation is know as the Fundacion Omar Dengo. Once the project was awarded to IBM, Fundacion Omar Dengo under the leadership of Clotilda Fonseca, its first director, set out to put Arias' plan into action.

The decision to place prime responsibility in the hands of teachers was the first decision made by the director and her staff. In discussing the role of teachers in the project, there were two choices available. One option was to put a turnkey system into place that would require very little from the participating teachers. The teachers who would be involved with the project would have little or no technical experience and it was argued that if the project were to be successful, little could be required from these teachers in the way of technical skills. This choice would be implemented by putting systems in place that would run CAI (computer aided instruction) software, similar to many Integrated Learning Systems being used throughout the US.

The other choice was to place the burden of learning computing at a fundamental level on the participating teachers. Teachers would be required to learn Logo and to use Logo as the medium of instruction once the program got under way in the rural schools of Costa Rica. Teachers would become competent users of technology as opposed to simple "appliance" operators.

The choice was to go with Logo and to put the onus on participating teachers to become full partners in the effort to introduce computing as an educational tool for developing creativity and logical thinking. This choice has led to an exemplary program in which hundreds of teachers, most of whom had no previous technical background, learned to program in Logo and developed a great sense of confidence in themselves and their country by mastering something that was experienced as challenging, modern, and difficult. Moreover, the vast majority of elementary teachers in Costa Rica are women and these teachers were now venturing into technology and computing, something considered traditionally to be in the realm of only men!

The choice was confirmed after an initial group of twelve teachers participated in an intensive three-week Logo workshop at MIT. These teachers would become the national tutors for the Informatics program and would share what they learned with other teachers in the rural laboratories throughout Costa Rica in a "teachers teaching teachers" model of in-service. The results of this workshop were outstanding. In his book, *The Children's Machine*, Seymour Papert (1992) makes the following observation about this initial training.

> It was obvious to all observers that an exceptional quantity of learning took place in these weeks. I think it was almost as obvious that this happened because the participating teachers felt that much more was involved than a technical improvement in learning basic skills. They were making a personal assertion of their will to appropriate this modern thing; a professional assertion against a view of teaching as a lowly profession; and a national assertion against the view of their country as underdeveloped. Many of them were also making an assertion of gender, for a large percentage of elementary school teachers are women and the organizers of the project had the good sense to reflect this in the selection process. (p. 76)

The three-week workshop at MIT was under the direction of Dr. Marilyn Schaffer, director of the Educational Computing program at the University of Hartford. Dr. Schaffer was on sabbatical from her position in Hartford and working with Seymour Papert in the Media Lab at MIT.

The International Center for Technology and Education

The tremendous success of the initial workshop at MIT generated such positive evaluation from the participants and staff that immediate plans were put into place to seek continued training for the tutors employed by Fundacion Omar Dengo. The twelve tutors initially trained at MIT would need continuous support in their efforts to train teachers and lab personnel throughout Costa Rica and as the number of laboratories established by the foundation increased, more tutors would be required. Discussion between Clotilda Fonseca, director of Fundacion Omar Dengo, and Marilyn Schaffer resulted in an agreement between the foundation and the University of Hartford whereby the tutors from Costa Rica would enroll in the Masters Program in Computing and Technology at the University of Hartford, under the University's International Center for Technology and Education.

The Masters Degree program enables students to attend classes on the University of Hartford campus for two summers and to continue their studies as distance-education students during the intervening fall and winter semesters. Each student is required to meet the normal requirements of the masters program. The coursework completed in Costa Rica involves scheduled meetings of students, telecommunications with instructors at the University of Hartford via Internet and fax, and regular visits from University of Hartford teaching staff. As well, the students attend regular classes in English speech and composition. These classes help students prepare for TOEFL, a requirement for graduation from the program. This requirement points to the unique nature of this graduate program. Although these students could attend classes as a group and instruction could easily be provided in Spanish, it was decided that fluency in English would be a valuable asset to teachers whose main area of work was in educational computing.

English is the language of choice in educational computing publications and at international conferences in educational computing. Thus TOEFL became an exit requirement for the students in the international program rather than an entrance requirement as is normally the case.

After two years of successful collaboration between the Center for International Education and Technology and Fundacion Omar Dengo, there were requests for information concerning the program from other centers in Latin America. The good word had spread during international computing and education conferences! These inquiries let to initial pilot projects with FUNDAYACUCHO and Projecto Simon centered in Caracas, Venezuela and with a group of educators from the Universidad De San Martin De Porres and the Franklin Delano Roosevelt School in Lima, Peru.

In the four years that the international program has been in place at the University of Hartford, there have been very few problems. This, in large part, is due to the continual effort of the director of the program, Marilyn Schaffer. As with any new program that moves away from the traditional ways of doing the job of educating students, the program needs to be continually promoted among regular faculty at the University. Programs involving large numbers of international students constantly place small inconveniences on the traditional, bureaucratic procedures that are a daily part of university life. There is always the problem, for example, of meeting deadlines for application forms, getting transcripts, and translating these transcripts. Simple problems such as the need for a social security number on a registration form can cause hours of paperwork frustration. Getting adequate housing on campus, sometimes at short notice, has been a continuous difficulty. This is particularly so now that some groups are coming on campus during the regular school year. None of these annoyances, however, has been substantive, but it has been necessary to continually anticipate and deal with the little difficulties before they grow into problems.

Advantages of An International Program

What are the advantages of such a program? I can answer this question from three perspectives: from the point of view of the University, from the international student's view, and as seen by our regular students.

To the University

The most obvious advantage to the University is the enrollment of students. This program started during a time of low university enrollments throughout the country. The program now caters to the graduate study needs of in excess of 100 students.

The beginnings of this program coincided with the revamping of our regular masters program in computing and technology. As we attempted to bring our course offerings into line with national standards, the possibility of international students forced us to take a more global view and to look carefully at the use of technology in actual instruction. Telecommunication is, therefore, a very important part of our program. It is also satisfying for the faculty, teaching in the international program, to be a part of some interesting and very successful projects in developing countries.

To the International Student

The first advantage to the international student is that they are part of a formal, graduate program at an American university. Prior to enrolling in this program, most of the in-service for these teacher educators was by way of workshops. While most of our initial group of students were elementary teachers, many of the students now enrolled in the program teach at universities or technical schools. These students, with degrees in Mathematics, Engineering, and Computer Science, have had no formal training in the educational use of technology and so our program provides valuable training for these educators.

Each summer our students are exposed to the latest in educational technology. We invite guest lecturers from all over the country to our campus to be part of our program. Students make regular field trips to centers around the tri-state area to view the latest technology and to meet with developers of this technology.

Finally, the international students are involved in cooperative learning in action. They work together to overcome any impediment caused by English language deficiencies. They have the opportunity to form collaborative projects with classmates from other parts of the world. Many of these collaborative projects involve their students with students in elementary and high school classrooms in the US.

To the Regular Student

The international program allows our regular graduate students to gain a global view of educational technology and its application. The most often talked about advantage, however, has been the opportunity for collaborative projects. Many of our regular students, teachers in the Hartford area, have ongoing projects between their students and school children in Costa Rica, Venezuela, and Peru. Several of our students have visited Costa Rica and Peru during school holidays. These friends from the Masters program always have a spare room!

Conclusions

The International Center for Technology and Education at the University of Hartford began providing a Masters Degree program for international students in 1990. As we move into 1995, this program now includes more than a hundred students from Costa Rica, Venezuela, Peru, and Taiwan. The tremendous growth of our program speaks of its success in meeting the needs of the international community. The benefits to the University of Hartford, the faculty involved in the program, and regular graduate students at the University have been immeasurable.

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Use of A Distance Training Program for Teachers of Mexican Indian Languages

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The program outlined here is expected to begin experimentally during 1995. Most of the program will be given at a distance with heavy reliance on e-mail and other sorts of telecommunications, although certain parts will require site visits by faculty. It will be at the graduate level *(diploma)* and will require two academic years of half-time studies.

It should be noted that at this time (November 1994), the program has not been adopted officially by any institution; therefore, this description is subject to change.

Introduction

México has 56 living indigenous languages. At one time it was commonly thought that all of them would disappear in a matter of years or decades but this has not been the case. Today, native speakers of Indian languages still make up at least ten percent of the total population. The Mexican educational system offers bilingual-bicultural education for children who live in Indian-language-speaking communities, which has helped to sustain the languages and, in some cases, to increase the number of speakers. However, this sort of education is not available either to communities where the ancestral language is no longer spoken or to residents of urban areas.

Over the last decade or so, there has been a growing interest in reviving the ancestral language in some Indian communities. Furthermore, ever larger sectors of the majority population have begun to feel a need to know an indigenous language. The communities that have decided to reinforce or revive their original languages are doing so, in the main, to build cohesion and identity. A similar process has been going on in many parts of the world for some years now. Among the majority population, there are many who no longer know which specific Indian language(s), if any, might have been spoken by their ancestors. There seem to be two reasons for learning an Indian language. On the one hand, there are those who feel that by doing so they will draw closer to the nation as a whole and/or believe that knowing an autocthonous language should be part of the cultural "baggage" of all educated Mexicans. On the other hand, many people have a concrete need for a particular Indian language. Some of these are business people who deal directly with Indian communities, but many others are professionals. This includes physicians, nurses, agronomists, veterinarians, teachers, lawyers, social workers and so forth, as well as anthropologists and sociologists who, at some point in their careers, if not throughout, must successfully work with members of communities where little or no Spanish is spoken.

The cultural and commercial reasons have always existed and, traditionally, have been satisfied by an individual's making some sort of arrangement with a speaker—almost anyone—of a particular language. At times, these arrangements lead to a person's actually knowing a language; often, however, they do not. The professional reason has existed at least since the middle of the last century, but it has virtually never been satisfied. That is in large part because universities and higher technical institutions (which perhaps should have made sure that their students had an opportunity to learn Indian languages) have, until recently, cavalierly ignored both the need and students' occasional demands that they do something about it.

Recent Changes

In communities where the ancestral language has,for all intents and purposes, been lost more and more parents are asking that it be taught by qualified teachers in a formal setting. This same sort of demand has made itself felt in the cities of regions where one or several Indian languages are "alive and well," but spoken only by a minority. In México City, groups of immigrants from other parts of the Republic have begun to want their children or grandchildren to learn their ancestral language in formal afternoon or weekend classes. Finally, a growing number of state universities now require functional proficiency in a local indigenous language to receive degrees in certain fields.

Students

The students of the teachers who will be trained in this program will, then, be both children and adults who probably do not live in Indian-language-speaking communities. Most will be enrolled in educational institutions of one sort or another (elementary, middle or high schools, language institutes, technical schools of different kinds, or universities). A growing number will need formal academic credit for their studies and some will have to be certified as functionally proficient in the language they have learned.

Official Recognition

Representatives of a majority of the larger Indian-language groups have made it clear that the diploma the program's graduates will receive must have official recognition from state educational institutions and systems_ although not necessarily from the federal one—and, to the extent possible, from traditional communal authorities. Therefore, the program will be submitted for approval, and modified as needed, before being opened to teachers from any particular language group or locality.

Aims

The aims of the program are:

- To train the teacher in the processes, particularly decision-making, that language teaching involves;
- To encourage independence, self criticism and creativity,
- To encourage trainees to participate actively in the development and spread of their indigenous language.

A program of this sort cannot be a "recipe book" for many reasons. For one, its graduates will be located all over the Republic, many working in relative isolation. They will need to be able to identify and analyze successes, failures, and everything inbetween; and to solve problems on their own. In addition, the sociocultural situation of each language is different and will need to be considered on a case-by-case basis.

Trainees

Only native speakers of a particular language who hold a university degree (*licenciatura* or higher) will be accepted. Persons with some kind of teaching experience (not necessarily of a language and at no particular level) will be given preference. (See the heading Complementary Program, below.)

Faculty

For the foreseeable future, most faculty will be drawn from the area of foreign-language teacher training, including Spanish as a foreign or second language. The faculty will be quite small, largely because the number of fully qualified foreign-language teacher trainers in México is, itself, relatively small. Of these, only a few can be expected to be willing to work both with the technology the program requires and with teachers of languages they do not know. The latter is inevitable due to the number of languages in question. The infinitesimal number of qualified trainers who are native speakers of an Indian language will be given an opportunity to participate.

All faculty will be bilingual, preferably trilingual, in Spanish, the *lingua franca*, and any other language(s). This requirement comes from the situated-cognition approach that underlies the program. It is felt that multilinguals will be more able to understand and communicate with the trainees, who are bilingual speakers of minority languages, and to help them attain the program's goals. Furthermore, it is felt that the fact that trainees are required to be bilingual and that their students will want to be, implies that the faculty, to be effective, cannot be monolingual.

Because the program relies heavily on telecommunication systems, it will be possible to draw faculty from any institute or university in the country and from foreign institutions, as well.

Educational Structure and Content

The program is modular and given over two academic years, divided into five periods. A heavy emphasis is put on project work of different sorts.

Faculty will work in teams only. This means that two or three trainers will take charge of a particular module/group and all will be equally responsible for its successes and failures. Other faculty members can be invited to intervene if their particular expertise is needed at a particular moment. The program takes the view that it is impossible for any teacher to act in isolation and be fully effective; the faculty will have to model this idea.

The theme of evaluation has been included in each module's program as appropriate; it is not viewed as separate from teaching.

Modules

The first period —ten weeks— consists of three simultaneous modules:

- An orientation to distance learning and the technologies involved in the program;
- An informational course on the basic concepts and terminology of Linguistics and Applied Linguistics; and
- Another informational course on language acquisition/ learning.

The two informational courses will be given in a relatively traditional and predictable way to give the trainees a chance to get to know each other and the faculty, and to become comfortable with the technologies.

The second period —20 weeks— consists of two simultaneous modules called "research forums." Both are based on discovery and ethnomethodological models. One is designed to guide trainees towards an understanding of the workings and ways of their own language, and to teach them research techniques with which they will be able to broaden and deepen that understanding. This forum is important because no Mexican Indian language has either bibliography or long-standing teaching traditions to underwrite it in an up-to-date sense. The other research forum is on students and teachers in both foreign language and other kinds of classes. Trainees will observe, study, describe and reflect on roles, actions, activities and materials, and their purposes and effects.

The third period (also 20 weeks) consists of two simultaneous "workshops." One is on materials and activities, and deals with putting together actual classes in the target language. The other is based on laboratory classes that will be team taught by trainees. During this period, members of the faculty will make four or five site visits. Although these modules require some macro level planning by trainees, all of this will be done with guidance from the faculty. Laboratory classes imply trail and error and discovery.

The fourth period —10 weeks— consists of one all encompassing workshop on macro level planning and syllabus design. Trainees will work in teams. Some products may be publishable.

The fifth, and last, period consists of a menu of elective courses from which each trainee must choose one. Each will last a maximum of 10 weeks. Unlike the rest of the modules, these can be given to mixed language groups. At the moment, none of these modules has been planned; however, the following course titles have been proposed: *Laboratory on Institutional Evaluation, Sociolinguistics of Minority Languages, Seminar on Organizing a Language Institute,* and *Workshops on Producing and Editing Materials and Books*.

Products

By the end of the program, trainees will have produced: action research project reports, bibliographic research reports; mock and real programs, lesson plans and evaluations; materials of various sorts and activity plans/descriptions; reports and videos of laboratory classes. Towards the middle and at the end of each period, trainees will organize their best work into portfolios.

Andragogical Evaluation

The decision as to whether a particular trainee (a) is progressing satisfactorily or (b) has satisfied the criteria of a particular module —and, ultimately, of the entire program— will be based on criteria proposed by faculty, negotiated with trainees, approved by faculty and advisors, and applied by both the individual trainee and faculty members directly involved with the module in question. As often as possible, and especially in those ethnic groups where it is an educational custom, peer evaluation will be used. In general, only those who clearly act in bad faith or totally irresponsibly will fail.

Program Evaluation

Because no individual faculty member will be teaching alone, short term program evaluation is expected to be a relatively easy, on-going process that will lead to learning and improvements of various types. Trainees will be involved in this process in a natural way. A small number of external advisor-observers will be involved throughout.

Medium-term, long-term, and independent evaluations will be based on as many different sorts of products as can be collected and stored. Additionally, for instance, occasional questionnaires written and evaluated by outsiders will be used. It is hoped that someone will undertake follow-ups on individual trainees. A major independent retrospective evaluation will have to be carried out after the fifth year of operations.

Technologies & Their Use

Bus and messenger services. Print materials, audio and video cassettes, and all student production will be sent back and forth by bus, usually, or a messenger service. These services will also be used for some kinds of communication among faculty.

Fax and telephone. Although these will not be used regularly, they will be available at all sites.

E-mail. This will be the major means of communication in all aspects of the program. Besides the faculty-trainee/trainee-faculty communications that the modules imply, e-mail will be used by both faculty and trainees to communicate among themselves. Trainees will be encouraged to write in their own language.

The following kinds of lists will be established:

- Private: By module and for all active trainees and faculty.
- Public: For trainees, graduates, faculty and ex-faculty, and all other interested parties.

Trainees and graduates who speak one particular language will be encouraged (and helped) to establish a discussion list in that language.

Audioconferences. These will be used largely for discussion classes, emergency explanations and clarifications, invited discussants, and meetings of various kinds. Audioconferences will not be used for lecture classes or speeches.

Videos. Two kinds of videos are foreseen: faculty-made and trainee-made. Faculty will prepare videos when experience suggests that this would be the most effective delivery system for a particular topic., Trainees will be encouraged to prepare videos as part of their work in the research forums and workshops. Some of these may have a wider application.

Trainer Education

It is hoped that this program will eventually be in the hands of native speakers of Indian languages. To achieve this aim, trainers will have to be trained. This means that Indians will have to choose teacher training as a career. It is felt that this program can be used to encourage the process. Three lines of action are foreseen:

Orientation

Experience has shown that discovery and ethnomethodological training models lead some trainees to think about the training process itself. Furthermore, the program offers an additional course for graduates and, possibly, others on the topic.

Practice

Diploma-holders will be welcome to stay in contact with the program if they desire to do so. Some will be contracted as facilitators, interns and/or advisors. This sort of contact and participation will give useful experience to future teacher-trainers.

Education

The program will carry out in-service training activities for its own personnel. Traditionally, this is done with short courses, lecture series, workshops and so forth. All of these activities will be open to the program's graduates, as well. In the end, those who choose to enter the field of teacher training will have to select a graduate program at a Mexican or foreign university.

Complementary Program

The fact that the program described above requires a completed university degree for admission is a direct response to a specific demand by representatives of several Indian groups. They want a "high level" program and the degree requirement is important to them. However, no one denies the fact that, until recently, many educational opportunities were not available to Indians for one reason or another. Therefore, it has been proposed that the "diploma" program be complemented by a "certificate" program that could be taken by persons who have completed high school or, perhaps, even less. As presently proposed, this lower level program would cover only the first three of the five periods of the diploma program. Trainee performance and production would be evaluated separately, even if both kinds of trainee are enrolled in the same group at the same time. Certificate holders will be able to complete the diploma program once they meet the higher admission requirement.

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An English Course by and for Telecommunications

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A one-year course is being developed and piloted by the Academic Computing Center of the National Autonomous University of México and the Center for Foreign Language Teaching with the support of the University's Program for Distance Education. This course was designed to meet the needs of the university community in overcoming two of the principal barriers to becoming full fledged members of the global community connected to the Internet: English and Computer Literacy. Although the technological infrastructure exists at almost all Mexican universities and despite the fact that net users are being incorporated at a rate of approximately 300 a day, net use remains limited and sporadic. Access remains a problem but in many cases this is illusory. The more serious difficulties are lack of knowledge and familiarity with net use. English also is not as great a barrier as it may seem. Most university students and faculty have at least a rudimentary knowledge of the language. This course in particular is aimed at a participant with a low intermediate knowledge of both English and computer use.

In order to meet these needs we designed a content based telecommunications course on a task-based model which incorporates collaborative learning and English language support. The delivery systems include: computer-mediated communications (CMC) — from e-mail to international relay chat (IRC) — audioconference, print, video cassette, audio cassette, and software and data on diskette. The course contemplates 200 to 300 hours of student work. Students and a local facilitator will meet weekly at the remote sites, where they will have approximately 1 1/2 hours of group work face-to-face in groups of three to eight. This time will allow them to view videos or work with multimedia programs as well as chat and discuss course work. Another 1 1/2 hours will be used for audioconference linked to both the originating site and the other remote sites. The remaining activities can be done at the students' convenience. Besides the obvious interactions by audioconference and face-to-face, the students will also be communicating with the instructor and the other students by e-mail. This communication will gradually extend to other users not in the class. As their skills develop, students will be extending their net use and sharing their experiences with the whole class. This type of communication will give them something to talk about, a necessary condition for a content-based approach.

Research in second language acquisition in classroom settings has identified various optimal conditions. Content-based programs in themselves allow the creation of most of these. They incorporate a focus on student needs and interests while giving practice in real life use of the language (Brinton, Snow, & Wesche, 1989, pp. vii-viii). Although these are necessary conditions, they are not sufficient in themselves. There are students who learn to speak a second language by themselves and without support, but these are few and far between. The more usual result of facing a student with the premature demands of interacting in a group of native speakers is not a gentle immersion in the target language and culture but submersion in a fast-moving stream of problems and frustrations. Teaching content in the target language is not enough. A program must also supply support based on both a content and a linguistic task analysis. (Hutchison & Waters, 1983) These two areas of support, content and language, are organized in our course by tasks at two levels. The first is by global tasks which correspond to four major units of work:

1. Share personal and professional information by e-mail and audioconference.
2. Participate in a discussion list on language or culture and discuss your experiences by e-mail and audioconference.
3. Select, download and exchange files and discuss the process by e-mail, audioconference and IRC.
4. Work up a project, with your team, on a theme of your choice using the resources available on the Internet and discuss your progress with the class by e-mail, audioconference and IRC.

The second level of tasks are specific tasks that derive from or are related to the global task. These are the units used to develop activities to work on skills and abilities necessary to carry out the tasks. These enabling activities may focus on language, content, or skills. For example, for the second week of class, the Global Task is still "Share personal and professional information by e-mail and audioconference." From this global task and from the context of the class itself, a logical specific task is "Introduce yourself to the whole class using e-mail." This is the goal for the week and the only obligatory activity. More advanced students who feel capable might stop here or engage in other related activities either from the materials of the course or of their own choosing. Less adventurous souls might take advantage of the materials provided which suggest such activities as these:

- Practice recognizing the meanings of various login scripts using the study guide and the exercise diskette.
- Filling out the chart for the order of the login from modems and from the various types of direct connections, using the study guide, exercise diskette and some field work.
- Reading the manuals for the various mail programs available at the remote sites.
- Practicing with the various mail programs at the remote sites.
- Working through the disk exercise for identifying the parts of a header.
- Accessing and rereading the introductions previously posted by the instructor and the local facilitators to the class.
- Reading the introductions from the examples in their data diskette and identifying the typical elements in their study guide.
- Working through the language exercise on professions on their exercise diskette.
- Exchanging private e-mail with each other or with the facilitators or the instructor, etc.

As can be seen, there is a great deal of flexibility in the type and the intensity of activity offered. The study guide contains not only the information and instructions necessary to carry out the specific task but will also contain suggestions for supplementary activities. The flexibility possible in such a task/content-based model allows students to choose activities that suit them; which, along with a selection of relevant tasks, is highly motivating (Candlin, 1987).

The same flexibility inherent in the design makes it ideal for a distance education approach where students have a much higher degree of control of their time and resources. The only fixed hours in any one week are the one and a half hours set for real-time activities done with all the participants. The hour and a half dedicated to face-to-face work with the local facilitator and fellow students can be scheduled at the convenience of the participants at each site. The remaining time is left to the student.

As an ongoing part of this course, faculty, staff, and students of the Department of Applied Linguistics' Teacher Education Program; teachers in the English Department at the Center for Foreign Language Teaching; and students and staff at the Distance Education Program at the Academic Computing Center of the National Autonomous University of México will be incorporated as participants, interns, or participant-observers. It is hoped that this policy will be extended to the other participating institutions as well. Task-based language learning and distance education are both relatively new practices in México and we hope that this course and others like it will provide a laboratory for some hands-on learning that can serve both.

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Creating a Space for Interactive Education: The Iberoamerican Association of Educational Television

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In 1991 the Government of Spain invited the Iberoamerican Ministers of Education to use the satellite HISPASAT, launched by Spain, to create a system of distance education. Within this framework the Asociación de Televisión Educativa Iberoamericana (ATEI), including around 180 Iberoamerican universities and Ministries of Education, was established in 1992. UNESCO was invited to design programs and collaborate with member institutions of the Association in international projects. UNESCO, aware of the wide range of possible educational uses the satellite offers, designated its Regional Office for Education in Latin America and the Caribbean (OREALC) to organize teacher training projects in order to test the system.

This article intends to show that educational television can be successful in the region (a) if it can become an interactive tool, (b) if constructive use is made of the possibilities television can offer, and (c) if it is complemented by other teaching devices for educational purposes.

I will begin by describing the problems that arise when television is used for education, considering the experiences of educational television during the 1970s in Latin America and referring to the comments of some of its critics. Then, I will illustrate ways to overcome these problems in order to give educational TV a new chance.

The main interest of this paper is how to overcome TV's pedagogical limitations. If we suppose that learning is a social process that requires interaction with others and that TV by itself is not an interactive medium, it becomes obvious that there is a need for a new pedagogical concept to be incorporated into the educational use of TV. This concept will be called *interactivity*.

Different dimensions of interactivity in education via satellite will be explained; in its geographical dimension: at a local, regional, and international level. It will also be explained in its organizational dimension: at a producer level and at a receptor level.

These considerations lead us the conclusion that another attempt at educational TV can be successful if revised by a new pedagogical concept. This allows us more than simply teaching new contents, but also experimenting with innovative ways of teaching.

Problems and Possible Solutions

In order for educational TV to be successful, it must offer solutions for the educational needs of the region. The Main Educational Project for Latin America and the Caribbean is to synthesize the needs of the region. The final document of PROMEDLAC V 1993 illustrates the main objectives that the Ministries of Education are trying to implement; that is, improvement of quality (with special emphasis on teacher training), equal opportunities in education, education towards democracy, and sustainable development.

At first glance, educational TV via satellite seems to be a valuable instrument for reaching these objectives. The programs produced focus on training and are distributed among the member institutions and Ministries of Education in Iberoamerica. Large scale distribution increases access to education, while cultural and environmental programs allow for the expression of cultural pluralism and contribute to the creation of a collective environmental conscience. Nevertheless, we have to consider the problems that contributed to TV's past failures, as analyzed by various Latin American researchers, before discussing a new attempt at educational television.

Lack of Massive Access

In *The Venezuelan Study on the Feasibility of a Regional System of Educational TV for South America 1977* researchers point out that TV has to reach a massive audience in order to contribute towards the democratization of education. However, to receive the ATEI's educational programs, a special aerial is needed, which only members of the association, mostly universities and Ministries of Education, possess. Consequently, it is not an open circuit permitting a massive access of in-service teachers to training programs, but a closed system addressing specific groups.

Lack of Economic Resources

The second obstacle consists of the high costs of video production and the lack of economic resources. Valerio Fuenzalida (1992), in article about TV and development says "it has been proved that the high economic cost of TV school is a disincentive for any state to invest large sums in this area." (p.86) Nevertheless, the problem of the Iberoamerican Educational Television is partly solved through Spain's generous three year offer to finance transmission of educational programs and co-finance production costs. Financial support assures the continuity of the project and the existence of a variety of producers essential to maintaining cultural diversity and interactive production.

Lack of a Scholarly Language

Fuenzalida (1992) concludes from the experience of the 70s, that "from a semiotic point of view, the iconic language of TV has shown to be more appropriate to fiction stories and emotional identification than to scholarly abstraction. TV is a means with an associative, glamorous and emotional language affecting more our fantasy and desires than analytical reason" (p.89).

This criticism of audiovisual language is often held by those who view learning as a purely rational process, in which facts are analyzed and new contents are being taught. Yet, in order to teach consciousness-raising issues, like democracy and environmental awareness, new teaching methods are needed. The aim is no longer the pure transmission of knowledge, but a change of conduct. It is TV's emotional language that can effect this change. Moreover, TV allows us to observe processes which are very difficult to explain orally or in a written way, such as medical operations, and thus constitutes an important means for training.

Lack of a Sociocultural Context

Mario Kaplun (1994) draws our attention to another problem, the decontextualization of educational programs. He states that

> it is homogenized educational material, uniformly built and produced in series, with a massive distribution, not allowing for the regional or sociocultural differences of those receiving it. These characteristics generate, consequently, a refractory system because educational messages ignore the local context and the previous knowledge of students. (p.7)

One of the Association's explicit objectives is to show the diversity of Iberoamerican countries through cultural and educational programs produced within the region. Each ATEI member represents an educational community, a society, a country providing the sociocultural context in which relevant programs can be produced and received. Yet, the lack of finance and specialized personnel makes local production difficult.

Lack of Specialized Personnel

The lack of specialized personnel constitutes a major difficulty for educational TV. Producers are needed, as well as teachers who are able to manage audiovisual language and transmit educational messages via TV. The long-term solution adopted by university departments such as TELEDUC of the Catholic University in Chile, consists of teacher and producer training teams. These teams define the objectives, the contents, and the adequate way of translating educational contents into TV programs to produce the desired effects.

Probably, as a consequence of an oral teaching tradition, there is little experience working constructively with audiovisual material in schools and universities. In order to overcome this difficulty it is necessary to organize workshops for the preparation of educational TV reception. The objective is to receive programs not in a passive, but in an interactive way so as to assure participation in the educational process.

Lack of Interactivity

If we really believe that not only communication but also learning is a social process, to be constructed by interaction with others, the problem of one-way programs and the passivity of receptors should worry teachers. Jose Joaquin Bruner (1986) suggests that "most learning in most settings is a communal activity, a sharing of culture, achieved through negotiation rather than being transferred from one person—the teacher—to another. This is especially true in a Latin American context where personal interaction is of great importance" (p.127). Therefore, it is essential for interactivity to be incorporated into any system that uses the new communication technologies for education.

The Importance of Interactivity

It has been argued that any type of TV educates interactively, because interaction exists in comparing information received via TV with one's own experience. The receiver naturally complements their own knowledge by either accepting or refusing the programmed information. However, the educational process is more than individual reception or rejection, it is also interpersonal

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interaction. Participating in interactive programs trains students in communication skills, and serves as a valuable preparation for democratic decision making.

Interactive Projects

At the moment, UNESCO, with members of the ATEI, is designing international projects incorporating the concept of interactivity. In the first project on teacher training for environmental education, eight universities representing six Iberoamerican countries are producing video programs that present experiences, methodologies and innovations in the field of environmental education. In addition, these videos draw from the diverse reality of teachers in the countries where the videos are produced.

The project includes two steps designed to ensure interactivity. First, the videos are viewed and discussed by an interest group within each participating institution. The target audience consists of students of education, teachers, and others interested in the topic. An expert in environmental education guides the discussion, enhanced by written material, explaining the theoretical background of the proposal.

Second, an international discussion on the proposal will take place. In the first phase of this discussion the questions and suggestions which arose during the local discussion will be sent to the producer of the program. Then, each institution will be connected via e-mail to four other members, forming a subgroup of five. Within this group, each participant will have the opportunity to exchange ideas and experience with colleagues in other countries.

This process allows us to take advantage of several different teaching devices. The videos illustrate and raise consciousness. The written material will deepen our understanding of the issues at stake. E-mail helps us to achieve interactivity and rapid communications between all the participants. In order to reach an educational and social effect, interactivity must have multiple dimensions.

Different Dimensions of Interactivity

In the projects organized by UNESCO and members of the ATEI, interactivity has different dimensions: a pedagogical dimension, which has already been explored, a geographical dimension, and an organizational dimension.

Geographical Dimension

The geographical dimension of interactivity exists on a local, regional and international level. Each video comes from a different sociocultural context. In the first step the receiver will discuss the video within her institution, which will allow her to compare it with her own teaching experiences and with the local reality.

Second, the proposal is compared at a regional level with experiences developed in the same area in other institutions. Finally, it will be compared at an international level. This way, each institution can, through comparison, define and maintain its social-cultural identity instead of conforming to the dominant international thought patterns.

Interactivity at an international level allows us to share new developments. For example, new software created by one of the member institutions can be demonstrated. However, one of the consequences of sharing new technologies and practices is that not all countries in the region have the same needs. What at first sight appears to be an advantage—to share the latest advances—runs into the danger of being an inappropriate technology due to the diverse realities, needs, economic resources, and cultures in Iberoamerica. Similarly, the pure transfer of images showing the possibilities of the processes and technologies based on latest technology may create needs or attitudes out of line with the actual possibilities of the receiving countries.

Organizational Dimension

We will now investigate the organizational dimension of interactivity, meaning the way production and reception of the programs are organized.

Production

An important objective of the ATEI is that programs have to be produced by universities and not by commercial producers in order to assure a content of academic quality and a cultural context. For this reason, each member institution is invited to participate in the production of videos. Nevertheless, this offer is restricted by some technical criteria. ATEI evaluates audiovisual production by applying standards of commercial TV. Such criteria inhibits the misuse of audiovisual language and takes into account the expectations of the audience in order to avoid boring educational TV.

As already mentioned, there is lack of professional equipment, as well as economic and technical resources in many of the member institutions. Often, this makes it difficult to produce according to the above mentioned standards in order to pass the evaluation criteria. As a result, materials from experienced institutions like TELEDUC from the Catholic University of Chile is used. This gives this institution greater influence in the transmission, disrupting the ideal balance of production amongst equals.

Moreover, it is doubtful that video production is an appropriate technology for universities with few economic resources; particularly if the resources are used to produce videos which probably will not pass the evaluation criteria. Because of this, it is important that each university define its own priorities and agree with the association in order to complement production components which are lacking.

Reception

The main idea of interactivity within the reception is that it allows us to teach new contents and to experiment with innovative ways of learning through group discussion and the comparison of models with one's own reality.

In order to empower the student within this new educational rubric, students must know what are the new pedagogical objectives, so that they can concentrate their attention on the relevant points. Guidelines emphasizing these points help to introduce the subject, to present the program and its educational objectives, and open questions and provide some reference points for further reading. Since learning is a social process, it is important to prepare and provide some reference points for further reading. Since learning is a social process, it is important to prepare not only the students, but also the teacher and the environment so they can work together toward the desired effect. In traditional teaching, teachers are the main source of information and protagonists of the educational process, which constitutes the base of their authority. Their role changes within educational TV because TV becomes the main source of information and the attention is no longer concentrated on the teacher. In this new environment, the teacher facilitates discussion, answers questions and helps to clarify concepts, with the main actors being the students.

The environment is important because it determines the emotional status of the receptor and his attitude. People usually watch TV in a comfortable environment, at a convenient time. Moreover, the composition of the groups receiving the programs will influence the reception. If the pedagogical objective is to demonstrate that different opinions on subjects such as democracy do matter, it is important to convoke a heterogeneous audience.

On the other hand, if the pedagogical objective is to show a certain technique to specialists, for example a new software to expert engineers, a homogeneous audience is more appropriate. In this case, the teacher would intervene more, helping the student to clarify doubts and explain complicated processes. In addition, the students can always review the material if the programs have been taped.

We have seen how important it is to define the role of the teacher in relation to the students, create a pleasant environment and clarify the pedagogical objectives. Interactivity consists in discussion, the participation of the students, the possibility of expressing doubts and opinions, and asking questions. The aim is to give the students more opportunities to participate in their learning process. If we take this objective serious, interactivity must be increased to a maximum providing the student with the opportunity to be a producer and transmitter of messages. Consequently, teleconferences must be developed in which every participant is both transmitting and receiving among pairs. This way, not only teaching but also the media could be democratized. Information technology, converted into such a communication media, allows the students to communicate and construct their own learning process with others without being limited by geographical distance.

Conclusions

It has been described in this paper how information technology television has several limitations when used for educational ends. Yet, interactivity allows us to point out ways of overcoming some of these limitations, making pedagogical use of this media. The objective of this article is to understand how it can be used for addressing educational needs.

First, we have seen that TV's emotional language and its potential for demonstrating positive conducts, makes it an ideal instrument to raise consciousness and motivate students.

Second, it has been shown how TV can contribute to teacher training, because it can demonstrate complex processes and can allow institutions and people with common interests to share innovative methodologies and technologies.

Most important for those working in education, is its potential contribution to the process of socialization. Sustainable development and substantial democracies describe possible ways of life in a community. In order to realize them, students will have to express their needs, compare different values, participate in decision making and respect the opinion of others. If all are to participate in their society, these skills have to be practiced from kindergarten onwards.

Last, but not least, training via television is an entertaining way of learning those elements which otherwise might be difficult to understand or simply boring. Educators might learn from TV to present contents in an innovative and attractive way, and to incorporate the concept of interactivity into the learning process. We hope that interactivity will diminish the discrepancies between those transmitting and those receiving educational messages. Our aim is to initiate a democratizing process in the schools through the use of communication technologies.

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Supplement:

Pilot project UNESCO-Iberoamerican Association of Educational Television: Tele-seminar on Environmental Education

The Tele-seminar on Environmental Education is a co-production of 8 different institutions in 6 different Iberoamerican countries (Argentina, Chile, Colombia, Honduras, Mexico, Spain) coordinated by the UNESCO Regional Office for Education in America Latina and the Caribbean.

The material (a video with written material) presents a variety of experiences in the field of environmental education: methodologies, innovations, etc. embedded in the specific sociocultural context of an institution or country.

The main objective of the Tele-seminar is to initiate an exchange of ideas and experiences in the field of environmental education throughout Iberoamerica. Large numbers of participants will be connected and organized into interest groups, overcoming large distances at low costs.

In order for a maximum number of participants to interact with each other, the transmission of the programs via the Spanish satellite HISPASAT is complemented by the use of e-mail which allows for an international discussion of the programs. The aim is to create a habit of discussing topics which are important to the universities, members of the Iberoamerican Association of Educational Television (ATEI), using the means of communication such as satellite and e-mail.

The programs of this first pilot project will be transmitted from May 1995 onwards. All institutional members of the ATEI (around 180) are invited to participate. The target audience consists of postgraduate students in education, teachers and professionals interested in the topic.

Each institution participating in the project is responsible for the convocation of an interest group and for the organization of the reception within the institution. For this purpose, a special class has to be prepared where the program, transmitted via satellite, can be viewed and an e-mail connection is installed.

The Tele-seminar will have two interactive dimensions. First, one program per week will be viewed and discussed by the local interest group. Each participant will have read the written material, which gives an in-depth analysis of the methodology or problem presented, before viewing the video in a group.

The discussion of the programs will be guided by a specialist in the topic. The objective here is to compare the presented methodology or problem with the local context and critically revise one's own way of approaching environmental education.

Second, an international discussion will take place, for which there will be two phases. In the first phase, each institution will synthesize all the questions concerning the program and send it to the university that produced the video. This should help to clarify doubts and provide an opportunity for obtaining more details.

In the second phase, each institution will form part of a subgroup of around five universities from different countries. Within this subgroup, each participant will have the possibility to share experiences, innovations, and questions, with participants from other countries. Afterwards, the result of this interchange will be published and is expected to exemplify a wide variety of experiences in environmental education.

It will be important to evaluate the Teleconferences impact given its innovative character. In order to ensure the widest participation possible in the evaluation process, each participant will be able to express his/her opinion in a questionnaire. Moreover, there will be one person in each university in charge of evaluating the experiment.

The evaluation will show whether it is advisable to organize more seminars in the future via satellite and e-mail. The main evaluative criteria will not only be the economic aspect, but also the quality of the discussion, the degree of interactivity, etc. The results will indicate in what way communication technology can really enhance the quantity and quality of academic exchange.

Multimedia Resources for Teaching Education: An Internationally Transferable Resource?

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MORE INFO
ON CD-ROM

The University of Exeter in England is developing multimedia resources for student teachers to enhance and improve courses for large numbers across the UK. Now, half way through this three year project, this paper questions the restriction of these materials to the UK. Colleagues from outside the UK will be shown the draft multimedia resources on barcoded videodisk and Photo CD and asked for their opinion. For example, could video of an English classroom enhance courses for American teachers? Alternatively, are the strategies for management of multimedia or critical situations dependent on the culture and accent of the 'actors'?

The project is also developing a framework for flexible learning that should not have a cultural bias. Perhaps, even if the materials will be inappropriate, the framework would be of value to colleagues in USA and elsewhere. If none of the materials prove to be transferable, then this may be a source for discussion of comparative education. The remainder of this paper describes the national project in the UK and a section of the resources under development.

The Images for Teaching Education Project

The funding council for higher education in the UK has an innovative program that has funded two phases of projects across the UK. The Higher Education Funding Council calls it the *Teaching and Learning with Technology Program* (TLTP). TLTP aims to increase the efficiency and quality of learning in higher education throughout the UK through the application of new technologies. Within the second phase of projects the Higher Education Funding Council for England funded the project *Images for Teaching Education* to make multimedia resources relevant to Initial Teacher Education available across the UK. The University of Exeter leads the project in collaboration with the University of Reading, Sheffield Hallam University, and the University of Northumbria. It is creating and implementing a range of multimedia resources that will enhance and extend initial teacher education throughout the UK. There are two main strands within the project:

1. Critical encounters within the secondary classroom
2. Multimedia in the learning environment

This paper will review the *Critical Encounters in Secondary Education* resources produced as one strand of the project. Additionaly, the paper questions whether the materials would be of value to teacher education taking place in other countries.

Critical Encounters in Secondary Education

Critical Encounters in Secondary Education takes some 'key' or 'critical' moments in school settings and explores different strategies to help student teachers manage these and other situations effectively. Whilst it is impossible to completely recreate reality outside the school, image-based technologies can provide access to surrogate classroom experiences. These may be used to stimulate focused interaction and discussion between student teachers and their tutors [supervisors], as well as providing resources that cater for a more flexible approach to learning. Alongside the materials the project is developing a flexible learning framework that responds to the need to integrate the materials into an appropriate self-study framework (Dillon, Hudson, & Tearle, submitted).

Practical training in classroom situations is of undisputed value in student teacher education. The recent UK government initiative to increase the proportion of time student teachers spend in the classroom supports this belief. However, it is impossible to provide all students with the necessary depth and breadth of experience. Similarly it is only possible to learn from complex experiences when they can be reviewed in an objective way. Whilst this is a valuable and central part of the mentoring process currently in place at Exeter University (Jennings, 1994), there are limits to the extent of this practical experience. There are also some situations that may not be desirable for student teachers to experience first hand within their school based work, but which nevertheless do occur in classrooms. We argue that discussion of the positive management of such situations has a place in teacher education courses.

The multimedia resources under development in this strand of the project give the user access to short video clips of classroom scenarios. The management of the scene depicted by each scenario could be of critical importance to the subsequent smooth running of the lesson and provision of a good learning environment. For example, there are video clips showing a teacher faced with managing various types of disruptive behavior in the classroom, such as the spraying of a deodorant aerosol or two girls who are shouting abuse at each other across the class. Another video clip shows school students directly challenging the teacher's authority by saying "Don't worry about her, she's only a student teacher." Clips also some focus on fairly standard occurrences, such as a school student who loses her purse and a pair of students who are chatting and off task throughout the lesson. Each of these sequences is about 30 seconds long and, in most cases, they are accompanied by several associated 'outcomes' or ways in which the incident could be managed. In some cases there is also a clip showing how a different style of management might have altogether averted the incident. The 'outcomes' are not to be taken as the best or only way to manage the classroom. Instead they are provided to encourage discussion and reflection.

Videodisk

The clips will be published on videodisk with access via a light pen wiped over a barcode. The videodisk will be accompanied by a wealth of barcoded support materials to allow for a variety of modes of use. For example, some materials are designed to support university tutors [supervisors] and mentors in using the videodisk resource to lead a tutorial session with a group of student teachers. Others are specifically written as flexible learning materials to allow a group of student teachers to work in a self supported manner at a distance from their tutor.

The clips themselves are designed to offer a visual stimulus for discussion, and it is envisaged that the majority of the discussions will take place after viewing and reviewing the 'stem,' which just shows the actual 'critical incident,' rather than the associated outcomes. Previous research (Wright & Tearle, 1991) found the availability of 'outcomes' enhanced, but was not crucial to the discussion.

Videodisk technology allows rapid random access to the video footage that is displayed at high resolution. The barcode contains information to directly control the videodisk player so no computer is needed. This makes the delivery hardware low cost and the resource transferable. The second audio track available with this technology offers additional possibilities to enhance the usefulness of the materials. In the pilot version an 'expert' commentary is available on this audio track for some of the sequences, and further development is underway in this area.

As well as being a user friendly and efficient way of enhancing existing provision for the topic of class management, the resources also give student teachers and university tutors an opportunity to use and see used one of the many technologies available to them today. Although confidence and competence with information technology are one of the criteria for student teacher education, current research continues to show that almost a third of UK student teachers enter the course with little or no awareness of its application in education (Coles, Higgins & Davis, 1994). Few have had experience of learning through IT.

Other Media for Images

It is envisaged that the same video clips will be disseminated in other formats. Use of multimedia communications technology is of particular interest and video CD is also a possibility. Samples of materials on Photo CD and in PowerPoint presentations will also be explored. This medium is chosen for ease of access and to empower student teachers and university tutors to adopt both the approach and the materials within their own teaching.

In parallel to this approach to class management, which is based on the use of video footage, the use of still images is being explored. Whilst the use of moving video was one the research group were familiar with, the use of high quality stills in the field of class management was new to them, and was less well documented. However, early ideas have been well received and the project has pressed its first Photo CD containing images of classroom scenes. This has been useful both to illustrate how these ideas may work in practice and subsequently to use as a basis for a pilot disc. The availability of audio to accompany each image has added an interesting dimension. A story board of still images and associated dialogue is currently under development on the theme of body language.

International Application

Reports from many countries suggest that the UK is not alone in seeking to prepare student teachers for a wide range of classroom situations they will have to face.

Footage taken in classrooms in Australia, USA, and Canada, for example, that was reviewed within this and previous projects, would seem to parallel incidents to those we have used. Critical incidents in the secondary classroom are not restricted to the British Isles! International audiences may find this UK sourced video footage useful. Although these multimedia resources are being developed within the UK framework for education, they may have relevance to a much wider international audience. It is noteworthy that the University of Exeter has successfully used Australian materials for developing effective class management strategies for a number of years.

Teacher educators in other countries could use the materials in one of several ways: complete items; a videodisk and its access index to allow users in other countries to use the footage for their own purposes; or simply to illustrate an approach. Thus the footage may be used on its own as a stimulus for discussion may be of value. The support materials are designed to focus the viewer on issues of verbal and non verbal communication, movement and position of the teacher in the classroom, use of threats and sanctions, etc. Many of the comments and strategies offered are likely to be relevant to users outside the UK. In addition, the instances that appear to offer a very 'British' approach could be of interest to those involved in comparative education or to raise inter cultural awareness.

The second way in which the materials may be of interest to a wider audience is simply to illustrate this approach. In the UK there has been considerable interest in this particular application of technology (Wright & Tearle, 1990). Perhaps others will find it an effective method and consider making their own version of materials in the same way as we are now doing.

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Teaching Teachers to Change: The Place of Change Theory in the Technology Education of Teachers

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> Goals, in the absence of a theory about how to achieve them, are mere wishful thinking. (Wise 1977)

The whole process of education can be viewed as a process of change and teacher education is no exception. Intending [preservice] teachers, in the process of their education, must take on board new knowledge, skills and attitudes if they are to perform effectively in classrooms. And the process of change is not limited to their personal development. Many practising teachers, teacher educators and external agencies argue that teacher education should be a vehicle of systemic change—it is one means whereby change for the better in schools can be accomplished. This paper argues that a greater conceptual and procedural knowledge of change can only help the process of teacher education, particularly in relation to the technological education of new teachers.

The Student Teacher as an Individual: Change in Knowledge and Attitude

Existing knowledge and experience have a strong influence on developing intending teachers' practices and teaching strategies (Oliver, 1994b; Stoddard & Gomez, 1990). Student teachers are very much inclined to teach in the way that they were taught and to model their practices on those that they judged to be effective from personal experience. Even when student teachers are presented with new possibilities, there is evidence that they filter and select from among the large amounts of information they are presented, those parts that fit their personal perspectives and intuition (Hollingsworth, 1989). Rovegno (1993), too, concludes that "the extent to which preservice teachers understand and use new curricular approaches appears to be influenced by the amount of congruence between the new approach and the preservice teacher's initial beliefs about teaching, learning and content" (p. 615).

Information technology (IT) poses an enormous challenge to the intending teacher because its use demands considerable shifts in the preexisting knowledge, attitudes and behaviours of these new entrants to the profession. In other words, all three dimensions of possible change identified by Fullan (1991, p. 37) are inherent in the educational use of technology. Many researchers support Wild's (1993) conclusion that a unique attribute of computers as an educational innovation is that their use demands many new skills and competencies and embraces changes to educational ideologies. Blease and Cohen (1990) assert that the fundamental change required to use computers for teaching is to teachers' existing conception of the teaching-learning process and of their pedagogic role within it (p. 29). Prawat (1992) identifies in computer assisted learning, a shift from conventional teacher-student dialogue to learning environments that are complex and interactive. Shavelson, Winkler, Statz, and Feibel (1984), Sheingold and Hadley (1990), Becker (1992) and Hall (1991) also accept that the use of technology may be changing the way teaching is conducted. In these studies, teachers noted a shift from teacher-directed teaching to student-centered learning. Teachers were using technology to encourage small-group instruction and were grouping students by interest to research various topics. When the students worked in small groups, the teachers found that their role changed from a lecturer to a facilitator who monitored student learning.

Some teachers can cope adequately with such large scale changes, some even welcome it. Huberman (1988), Hopkins (1990), McKibbin and Joyce (1980) and others found that the psychological state of a teacher can be more or less predisposed towards considering and acting on changes for improvement. Eraut's (1988) study, specifically into reasons for differences in uptake of information technology in schools, found some teachers whom he describes as 'cosmopolitan' — teachers who seek out opportunities for change, enjoy risk-taking and are willing to work with new methods of learning.

But not all teachers, and certainly few new recruits are like this. Gillman (1989) carried out a metasynthesis on computer assisted learning research studies about the educational adoption and implementation of computers and came to Adkisson's (1985) conclusion that " ... teachers, as a group, are the most conservative with respect to the acceptance of microcomputers" (p.3). Although there are growing pressures for teachers to embrace information technology into classroom teaching, where there is no mandated or specific need, there will continue to be reluctance and resistance on the part of teachers to change from traditional instructional processes with which they are familiar and comfortable.

A recurrent theme of change theories, however, is that change should be viewed positively and confidently. This is not to say that change is not uncomfortable: "Almost every important learning experience we have ever had has been stressful" (Block, 1987, p. 191), and Schon (1971 p.12) reminds us that all real change involves passing through zones of uncertainty—the situation of being at sea, of being lost, of confronting more information than you can handle. Fullan (1991) claims that "Conflict is [also] fundamental to any successful change effort"(p.27). Despite all this, however, change theorists argue that the teacher can, and should, adopt a positive attitude to change and learn to accept it as a valuable part of professional development: "Success in school change efforts is much more likely when problems are treated as natural, expected phenomena, and are looked for.... The anxieties of uncertainty and the joys of mastery are central to the subjective meaning of educational change (Fullan, 1991, pp. 28 & 32). Developing these confident, positive, pro-active attitudes in student teachers should help them cope more confidently with major learning difficulties in their professional technological education.

Innovations in education are frequently avoided if current methodologies appear to be serving their own purposes and no real need for change is apparent. Change is more likely to occur when people can relate the change to need (Louacks & Hall, 1979; Wu, 1988). Blumenfeld, Hirschbul, and Rubaiy (1979) argue that conventional teaching methods have provided independence, self-sufficiency and autonomy for the teacher; therefore patterns of behaviour that have rewarded in the past will be maintained until expectations of better rewards can be perceived. So student teachers might well be reluctant to invest additional time and energy to incorporate a new technology into their methodology when, as practitioners, teachers have already developed adequate solutions to their pedagogical problems. Consider, for example, that one of the most salient issues for new teachers is their fear of indiscipline (Loveless, in press). In discussing the cost-reward structure of using computers, Blumenfeld et al (1979) argue that "the perceived benefits (of using computers for teaching) must be weighed against the risk of disrupting survival techniques" (p. 191). The presentation of technology in teacher education programmes must relate to the classroom needs which student teachers recognise—or which they can be prompted to appreciate and accept. Orlich and Ezell (1975) argue that training can be successful 100% of the time if programs are judged relevant by the learned recipient group.

The Bahaviour of the Student Teacher in School

Initial teacher education in technology has had some impact if success is measured in terms of actual or perceived cognitive outcomes and changes in attitudes (Oliver, 1994b). However, it is important that information technology programmes are also measured in terms of their success in influencing behaviour—most importantly the use of information technology in the classroom (Oliver, 1994b; Wild, 1993, & in press). Here the picture is less satisfactory. Downes (1993) found that less than 50% of student teachers at the University of Western Sydney were using computers for work on a final teacher practice. Handler and Marshall (1992) found that less than 20% of beginning teachers surveyed felt prepared to use information technology in their teaching whilst a smaller minority actually used computers in their classrooms. Oliver (1994a) found that among West Australian beginning teachers 75% did not make use of computers for instructional purposes even where there was good access to hardware and software. Increasing numbers of students are receiving some training but studies of computer uptake that have been conducted among new entrants (Novak et al, 1991; Dunn & Ridgway,1991a & 1991b; Monaghan, 1993, Oliver, 1994a) frequently demonstrate that formal information technology programmes within teacher education courses are not as successful as might be wished. These findings support the general theory (Lavisky 1969, McClelland 1968) that new knowledge and attitudes by themselves are not usually sufficient to bring about a change in behaviour. Almost all worthwhile educational changes require new knowledge, attitudes AND behaviour (Fullan, 1991).

The interplay between teachers' knowledge and attitudes on the one hand and the institutional characteristics of the teaching placement on the other are important if we are to understand what student teachers actually do (Bliss, Chandra & Cox, 1986; Chandra, 1986; Chandra, Bliss & Cox, 1988). The institution provides the context wherein teachers develop their ideas or change their attitudes about the use of computers in teaching.

Contact between student teachers and technology-using teachers in schools can prove a very significant influence on later professional practice (Goodwyn, 1992; Handler, 1993; Lanier & Little, 1986). But not all teachers with whom student teachers come into contact use technology. Some teachers will be hostile to it—often for the reasons cited above in relation to student teachers. Whole schools might be resistant to technology. As institutions, they are static places. Many researchers (Cuban, 1984; Goodlad, 1984; Hall, 1991; Kerr, 1989; David, 1991; Papert, 1993) have indicated that schools have changed very little in the last century. What appears to outsiders as a straightforward improvement can, to an organization, be felt as undesirably disruptive if it means that the culture must change its values and habits in order to implement it. The fundamental instinct of durable organizations is to resist change: that is why they are durable (Hodas, 1993). Student teachers should be aware of a natural resistance to organisational change in schools and understand that this might play an important part in shaping the institution's response to the use of technology.

On the other hand, there will be individual teachers and whole institutions more amenable to the use of information technology in the classroom. Even here, however, the situation for the student teacher can be problematic. Student teachers can be faced with excessive expectations of what they can deliver.

"We are looking to the students to help us in ways of organising IT to promote teaching and learning ... they can help us in our difficulties". (Loveless, in press)

Pressure may come from several directions:

School systems, teachers, parents and children talk about computers as they never talked about programmed learning, educational television, open education or raising the school leaving age, for that matter. Schools must have computers. (Olson, 1988, p. 1)

The pressures may be unrealistic or not obviously desirable. Politically, information technology is highly charged and instrumental (Robinson, 1993). To make a truly professional response, intending teachers must be equipped with the ability to see clearly and critically the values being ascribed to technology, the motives propounded for using it and the consequences for ways in which they might (or are expected) to introduce and use information technology in their teaching.

There are many organisational factors influencing student teachers' use of technology in schools. For example, Rhodes and Cox (1990) found the development of school computer use by student teachers to be influenced by four major factors: teachers' attitudes to the technology, the attitude of the principal, timetabling arrangements, and the fabric of the school building. Student teachers must learn how to cope with such obstacles effectively.

There is little evidence that student teachers are prepared to cope with the realities of school situations especially where information technology is not already widely utilised. Traditionally problems of institutional innovation are not considered in initial teacher education: "They [student teachers] must have abilities that are barely (if at all) touched by the formal teacher education program... In short, not only are there difficulties in learning how to use new methods (such as applying theory to practice), but there is also an almost total neglect of the phenomenon of how changes are and can be introduced and implemented". (Fullan, 1991, p. 300-301)

At the end of a lengthy review of the growing wealth of literature on the subject of technological innovation in schools, Grunberg and Summers still argued that:

> Computer innovation in schools is not, we feel, a topic of any great priority for teacher trainees. In initial teacher education the emphasis should be on developing classroom competence with information technology and encouraging student teachers to think critically about its role in teaching and learning. Problems of institutional innovation and change are far more likely to be the concern of school principals, senior managers, regional or national advisers, curriculum development agencies, and government ministers. (p. 272)

And in Canada, Fullan carried out a national survey in which only 15% of teachers and teacher educators felt that their programmes were preparing teachers to any great extent to have the perceptions and skills to implement changes in schools (Fullan, 1991, p. 300-1).

If student teachers are to use information technology successfully in schools (or if at all) they must be aware of the naturally existing mechanisms which operate in school environments and be equipped to deal with them effectively.

The Student Teacher as an Agent of Change

Student teachers must learn how to become effective change agents if they are to use technology effectively in schools. An effective change agent is a teacher who can take responsibility and action to exploit the many opportunities for bringing about improvements (Fullan, 1991, p. xiv). For student teachers, this means bringing about improvements in their own teaching but, as I have indicated above, it might also mean effecting improvements within a wider school context if student teachers are to obtain the necessary conditions to enable them to use and develop technology as a resource in their teaching. Evolutionary planning and problem solving models based on knowledge of the change process are essential (Louis and Miles, 1990).

An effective change agent is also one who knows when NOT to act. The major initial stance should involve critical assessment of whether or not action is desirable in relation to certain goals and whether or not it is implementable — in brief, whether or not it is worth the effort. The most responsible action may be to reject goals and actions that are bound to fail and to work earnestly at those that have a chance of success (Fullan,1991, pp. 103-104).

In short, individuals should have the capacity to know when and how to pursue and implement certain change possibilities, to know when to reject others and how to cope with policies, programmes and constraints that are imposed upon them (Fullan, 1991, p. xiii). Fortunately, there is an increasing corpus of literature on technological innovation in schools to help them; (see Grunburg & Summers, 1992). In addition, as Grunburg and Summers point out, the development of information technology in education can be seen as part of the broader field of educational change in which there is a rich and useful literature. According to Cox and Rhodes (1989), it has been recognised that many of the barriers to the adoption of microcomputers in schools are specific examples of the barriers to change in general. This suggests that a broad approach to the study of issues involved in using computers in schools is warranted. The use of computers may be considered as a specific case of school innovation in general, and therefore potential technology-using teachers might benefit from the considerable range of research existing in that area. Teacher educators should use this knowledge to understand better the nature of the task facing them and also the task facing their students. More than that, an understanding of the phenomenology of technology innovation in particular, and of educational change in general, ought to be required of every student teacher to help them plan for professional development and to create the conditions which enable that development to occur —personally, and in school contexts — in a realistic and positive manner. Such a dimension in initial teacher education would also lay the foundation for the role of new teachers as technological innovators in schools — a role they might well exercise unexpectedly quickly, given the current state of IT use in schools.

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Comparing Attitudes Toward Computers of Polish and American Prospective Teachers

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The work presented here is a second report from a long-range project on studying students' attitudes toward computers. The project started from our skepticism of the wide-spread belief that prospective teachers are less likely to embrace computer technology than other students. The first set of results was presented in Paprzycki and Vidakovic (1994). In that study, the differences between the attitudes toward computers of students of the University of Texas at the Permian Basin (UTPB) and the University of Hartford (UH) was studied. Our data at that time indicated that the choice of becoming a prospective teacher has a minimal correlation with the students' attitudes toward computers. We have found that the primary factors were gender, age and the school attended. Since then three things have happened. First, Stanislaw Ubermanowicz (of Adam Mickiewicz University, Poznan, Poland) joined our team; second, a series of modifications to the initial instrument was made; and third, we have collected additional data at St. Cloud State University (SCSU) and Adam Mickiewicz University (AMU) as well as increased the total amount of data collected at UTPB. The primary aim of this paper is to present the results of comparing the attitudes toward computer of Polish and American students (prospective teachers and other majors). In addition we made a number of comparisons similar to the earlier study studying the correlations between age, gender, the school attended, and attitudes toward computers.

Methodology

To obtain measures of students' attitudes toward computers, a self-report questionnaire based on a five-point Likert scale (Grounlund, 1981) was developed. It consisted of 24 statements expressing positive and negative attitudes toward computers, acquiring knowledge about computers and their use, and a computer literacy course. These questionnaires were administered during the initial meetings of computer literacy courses offered at different institutions. The early results have been presented in Paprzycki and Vidakovic (1994). In the next step, a small number of changes (based on the analysis of the data, input from our colleagues, and the students' comments) were made. Some of the original statements were rewritten to make them clearer to the students (e.g., complex and long sentences were rephrased), one of the original statements was removed (No. 13, see Appendix). There were two goals of the creation of the updated version of the instrument. First, to make it clearer to the responding students and second, to be able to reuse previously collected data. We have decided that since the changes were relatively small, the data collected earlier can be combined with the new data. The Appendix contains the new version of the survey. It is worth mentioning that translating the survey into Polish was quite a challenge (details of this process can be found in Ubermanowicz and Paprzycki, in preparation).

To each statement, participants selected one of five options on a Likert scale by indicating whether they *strongly disagree, disagree, undecided, agree, and strongly agree.* Weights were assigned to each response. For statements expressing a positive attitude the assigned weights were: 1- for "strongly disagree," 2- for "disagree," ... 5- for "strongly agree." For the statements expressing a negative attitude, the weights were reversed. The results were statistically analyzed using ANOVA combined with the Duncan's multiple comparison test (for the statistically significant ANOVA results). For the multiple comparison test the standard significance level of 0.05 was used.

In choosing the factors with respect to which we analyzed the data, we have elected to match the previous study. The students' attitudes were studied from five angles. First, overall attitude was considered. All of the statements except No. 13 were combined. (Since the data from the earlier version of the survey was combined with the data collected using the new questionnaire, we have omitted the responses to the old version of the statement No. 13 as well.) As previously, in addition to the study of the overall attitude, statements were combined into four groups representing particular areas of interest. Statements 1, 2, 4, 6, 7, 8, 9, 16, and 21 characterize the individuals' current feelings about computers. Statements 3, 5, 17, 20, 22, and 24 assess the perceived personal need for the computer (in the past, the present and the future) and the perceived overall role of computers. Statements 10, 11, and 15 address the individuals' attitudes toward acquiring knowledge. Statements 12, 14, 19, and 23 deal with the attitude toward the computer literacy course itself.

Four factors were considered: age, academic major, gender, and country. Students were divided into three age groups: young (age below 21 years), middle-aged (between 21 and 27 years) and older (age 28 and above) students. Academic majors were combined into 5 groups: prospective teachers, natural science students, arts and humanities students, business students and undecided. However, since our primary goal was to study the attitudes of prospective teachers, we have also divided the students into two categories: the category prospective teachers and the category comprising all the other majors (for ease of reference, we will call them "non-teachers"). Then, we ran comparisons between Polish prospective teachers and non-teachers, American prospective teachers and non-teachers, Polish prospective teachers and American prospective teachers as well as Polish non-teachers and American non-teachers. Finally, we have performed a general comparison between the attitudes of Polish and American students.

A total of 68 individuals was surveyed at UH: 34 females and 34 males; 61 young students, 6 middle-aged and 1 older student (with the median at 19 years of age); only 2 students were prospective teachers. A total of 193 individuals were surveyed at UTPB: 122 females and 71 males; 60 young, 58 middle-aged and 75 older students (with the median at 27 years of age); 53 were prospective teachers. A total 36 surveys were collected at SCSU: 25 females and 11 males; 18 young, 13 middle-aged and 5 older students (the median was at 21). All of the students were prospective teachers. A total of 81 individuals was surveyed at AMU: 50 females and 31 males; 78 young, 1 middle-aged and 2 older students (the median at 19). There were 33 prospective teachers in this group.

Results

In the following subsections, only statistically significant differences among the various categories are reported.

Overall Attitude

We have found that the overall attitude of Polish prospective teachers toward computers is slightly less positive than that of American prospective teachers, and that the attitudes of Polish "non-teachers" are also minimally less positive than their American counterparts. In general, students at UTPB had the most positive overall attitude toward computers of all the four universities, while the students at AMU- the lowest. The only other noteworthy fact was that the middle-aged and the older students had similar and more positive overall attitudes toward computers than the young students. This last fact may explain why the students at UTPB had so high an overall attitude toward computers: of the four universities, UTPB has the highest proportion of older students.

Feelings about Computers

The only difference observed was that students of AMU, UH and UTPB have similar levels of comfort with computers whereas SCSU students felt less comfortable about them.

The Perceived Role of Computers and the Personal Need for a Computer

We found that Polish non-teachers perceive much smaller need for computers than their American counterparts (also the overall perception of the need for and role of computers of Polish students was much lower than that of American students). If we compare the attitudes across the four schools, UTPB and SCSU students perceived need for and role of computers was similar and higher than that of UH students, which in turn was higher than that of AMU students. The only other statistically significant difference was that young students perceived lesser need for and role of computers than the remaining two student age groups. Again, the large proportion of older students at UTPB can explain this fact. It is interesting to note that although SCSU students feel uncomfortable with computers, they nonetheless perceived a definite need for computers and recognize their important role.

Attitudes toward Ccquiring Knowledge

We have found out that Polish prospective teachers have a more positive attitude toward acquiring computer knowledge than Polish "non-teachers" (which goes against a widely held belief in Poland). At the same time, American "non-teachers" have more positive attitudes toward acquiring knowledge than Polish "non-teachers" (overall, the attitude toward acquiring computer knowledge of Polish students is lower than that of American students). UTPB students have the most positive attitude toward acquiring computer knowledge while the attitudes of the students in the remaining three schools are close to one another. Again, age is an important factor: older students have a more positive attitude toward acquiring computer knowledge than do young students. (Once again, this explains the very positive attitude of UTPB students.)

Attitudes toward the Computer Literacy Course

We have found that American "non-teachers" are more positive toward the course than Polish "non-teachers" (the overall attitude of Polish students is less positive than that of American students). Let us note that this corresponds with the above result: not only is the attitude of American "non-teachers" toward acquiring computer knowledge more positive than that of their Polish counterparts, but so is their attitude toward the computer literacy course. The UH students have the lowest attitude toward the course, whereas the UTPB students value this course the most; the remaining two schools represent an in-between attitude. As previously young students have less positive attitudes toward the course than the remaining two age groups. It is only in the attitude toward the course that a difference between the five groups of academic majors was observed. We have found that business majors have a significantly more positive attitude toward the course than the other majors, indicating perhaps an increased awareness of, on the one hand, the usefulness of the computers and, on the other, the inescapability of their future encounters with them.

Conclusion

We have presented the results of a comparative study of attitudes toward computers between students of one Polish and three American universities. Not unexpectedly American students express more positive attitudes toward computers than do Polish students. This is probably explained by the fact that in Poland computers are still largely inaccessible. Computers are expensive; not only can the majority of people not afford one, but neither can schools (at any level, including the universities).

We were not able to find evidence that becoming a prospective teacher has any correlation with attitude toward computers. The only important factors influencing attitude were: age (young students exemplify less favorable attitudes than do older students) and the school attended. It can be questioned, however, whether the latter factor is really significant. It is possible that the results could be explained in terms of students' age (the correlation in the results between age and positive attitudes was very strong, since the samples were uneven in terms of both age distribution and gender distribution.). Academic major as well as gender were not found to be significant.

Currently we have started additional data analysis where the relations between the statements as well as how well each statement discriminates the attitude in question, are studied. The cooperation with Adam Mickiewicz University allowed us also to find that some of our assumptions about students' perceptions as positive or as negative may be incorrect. Our initial assumptions were that our attitudes and attitudes of our students were rather positive-or at least we interpreted it this way. Only the confrontation with the results from a less favorable environment and listening to the comments of some Polish students pointed to us the need for reevaluating our initial assessment. We expect, by the end of Spring semester 1995,to have designed a new instrument, taking into account all of the above information. At the same time a database, currently being developed, willbe ready to facilitate automatic data collection. Finally, we would like to invite readers of this paper who are interested in using our instrument to contact us.

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Appendix

Indicate the extent to which you agree or disagree with the statements listed below. Be sure to respond to every statement.

1. I am frustrated by computers.
2. My experience in working with computers is positive.
3. Many times in the past when I needed to use a computer I didn't know how to do it.
4. I feel comfortable each time I start to work with computers.
5. I will use the computer after college.
6. Only smart people use computers.
7. I think that I will be successful working with computers.
8. I am afraid that one day computers will take over and enslave people.
9. I think that computers save me time.
10. One can learn about computers by her/himself.
11. I am interested in learning more about computers.
12. Computer literacy courses should be a requirement for all high school students.
13. I have used computers in the past.
14. This course will make me appreciate the use of computers in my field.
15. I am always ready to learn new things.
16. I feel uncomfortable when I see that other students know more about computers than I do.
17. I think that the computer is a tool that I will need to use.
18. This course will help me in other courses whrer computers are used.
19. This course will have a big impact on my choice of courses I will take next semester.
20. Using computers should be a part of all courses.
21. One can get addicted to the computer just as one can get addicted to drugs.
22. In the future I definitely expect to use computers.
23. Taking this course will help me improve my attitude toward computers.
24. I think that the role of computers in daily life will increase in the next ten years.

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Training Students in Russia to Teach Mathematics with Information Technologies

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The system of training future math teachers in Russia, as well as in the former Soviet Union, has been in a state of transformation, innovation and adjustment during the last 25 years. However, despite all these reforms, the system of higher education (including that of training Russian math teachers) remains fundamentally different from that found in the USA and Western Europe. This paper will describe a system for training future Russian math teachers to use new information technologies.

Features of Russian Higher Education

A teacher training program in Russia is a five year program, without the intermediate Bachelor's degree, culminating in a Diploma that is equivalent to the Master's degree in the US. Upon entering a higher educational institution, a secondary school graduate selects a specialization. This is similar to an American student going to medical, law, or other graduate school. Thus, the curriculum is eighty percent predetermined by a chosen field of study and future professional activity. Consequently, the mathematics teachers information technologies training program remains as a five year study course.

Forms, structures, and content of teacher training are practically identical and uniform in all teacher training universities throughout Russia. Under the previous, as well as existing system of Russian higher education, leading universities, selected by the Ministry of Higher Education, to a great extent, determine the policies in the curricula of education in universities nationwide.

Concepts for Training Future Math Teachers in Russia

Concepts developed by the author and his colleagues are currently being implemented at the School of Mathematics at Moscow State Pedagogical University (MSPU). This school has more than 1000 students and 150 faculty and is the leading math teacher training school in Russia. Since MSPU is the leading teacher training university in the country, the structure and content of the curricula and new information technologies courses is reflected in other Russian teacher training universities. Due to lack of availability of hardware in most Russian universities, drastic cuts in funding and general chaos in Russia at present, it cannot be claimed that the discussed concepts have been fully implemented at all pedagogical universities of the country, or even fully implemented at MPSU. However, we hope that it is just a matter of time before the structure of the curricula and the planned content for new and existing courses will be implemented.

Publications on the Developed Concept

The results of the developed concepts were described in a series of publications. Bouniaev, (1986) indicates that following the introduction of information technologies in schools, changes in the system of training math teachers were proposed. The emphasis was on using these concepts and changes from the very beginning of restructuring the system of math education.

Bouniaev, Kusnetsov, Matrosov, & Shariy (1989) state the objectives for training teachers to use information technologies as they relate to school practices. The article *Training of Teachers as an Essential Element of Introducing Information Technologies into the National Economy* (Bouniaev, 1991) came as a response to the Russian government's underestimated importance of training teachers to use new information technologies. Arguments are presented which favor immediate and high priority investments in teacher education and introduction of new technologies in the schools.

Bouniaev, Matrosov, Kusnetsov, and Jdanov (1993) and Bouniaev (1993) discuss different elements for training future math teachers, including the use of new information technologies. Considering the differences between the educational systems of Russia and the USA and Western countries; it was not feasible to apply research results to Russian realities for the practical application of information technologies.

In developing these concepts, the articles *The Development of Multimedia Instructional Materials in Teacher Education*" (Abate, 1993); *Technology and Mathematics Education: A Survey of Recent Developments and Important Problems* (Fey, 1989); *Technology and Mathematics Education* (Kaput, 1992); *Training Mathematics Teachers to Use the Computer in Instruction* (Steen & Taylor, 1993) are particularly enlightening in the context of the current adjustment of the Russian system of education to that of the USA and Western Europe.

Concept Introduction and Evaluation

We have already mentioned the impact of the concepts developed at MSPU which were introduced to teacher training nationwide. Here we describe only the practices of the School of Math of MSPU which graduates seventy percent of all math teachers in Moscow. The process of development and introduction of the concept for training future math teachers consisted of several stages:

Stage 1. Defining the objectives within the context of a nationwide campaign to introduce new technologies and new teaching environments.

Stage 2. Determining the means of training future teachers to use information technologies in the classroom.

Stage 3. Conducting a feasibility study to accomplish the defined objectives and means described in stages 1 and 2 and within the framework of the existing curriculum, assuming that drastic structural curriculum changes would result in development of new concepts for training teachers.

Stage 4. Correlation of the objectives and means determined described in stages 1 and 2 with other objectives and means for training future math teachers.

Stage 5. Adding new courses to the curriculum and revising existing ones in view of the new objectives.

Stages 1-5 dealt with the theoretical aspect of the problem and resulted in the development of a concept for training math teachers to use information technologies in the classroom. This project was of an interdisciplinary nature. Teaching experts in mathematics and computer science, pedagogy and psychology; and general education participated in the work. The concept was also evaluated by a team of leading mathematicians and computer science professors from universities and research institutes across the country. It was also evaluated by a team of Moscow school mathematics teachers (alumni of MSPU). They reviewed the concept from the practical standpoint, how it compared with the training they had and how it would affect and fit the secondary school realities. During the first year of concept implementation, procedures for monitoring were developed and executed.

Curriculum Structure

In developing the concept for training future teachers to use information technologies, we proceeded from two principles. First, there was no need to change the current structure of the curriculum since the existing approach to training teachers seemed to be viable, working and effective. This would have required development of radically new concepts of training teachers. Feasible adjustments and changes have been made without changing the existing teacher training system. Second, we proceeded from the assumption that training future teachers in the use of new information technologies cannot be provided exclusively through specific disciplines. It should permeate all the components of the educational process.

Based on these principles, we evaluated the existing mathematics teachers' training curriculum. Using pedagogical priorities, we tried to solve the problem of training teachers to use instructional technologies for improved classroom performance. In general, curriculum courses fall into five cycles: mathematics and computer science; psychological-pedagogical disciplines; methods of teaching math and methods of teaching computer science; general education courses; and preservice training.

Fundamental training in all disciplines is the cornerstone of mathematics teacher education in Russia and also applies to training teachers to use information technologies in school. In reality, it meant that we moved from training mathematics teachers to training teachers of mathematics and computer science. This change involved introduction of new theoretical computer science courses and revision and extension of some of the existing ones. Computer science courses provide theoretical knowledge in computer science and an understanding for the potential for using information technologies.

Basic math theory is attained during the first two years of university studies. Thirty percent of the time allocated for study of all math disciplines is in mathematical analysis, algebra and geometry. In teaching fundamental mathematics, students are encouraged to develop basic educational software skills and research skills. Corresponding sections of the above mentioned disciplines constitute the core of school mathematics courses.

In learning fundamental math, students become familiar with software such as drill-and-practice, inquiry systems, tutorials, simulation and animation, software testing, and others. *Derive* and *Mathematica*, computer algebra software, play a special role in teaching mathematical analysis and algebra. Systems similar to those described in the article, *Computer Experiments in a course for mathematics teacher* (Morris, 1992), are being actively developed for the study of geometry.

An additional thirty percent of the curriculum is comprised of more advanced math courses. We assume that the role of the advanced math courses, from the point of view of training students to use information technologies at school, is less significant than those of math analysis, algebra and geometry. However, some sections of the theory of functions of complex variables, probability theory, and mathematical statistics provide numerous opportunities to demonstrate the modeling capacities of information technologies.

Training students to use information technologies through fundamental mathematics is empirical in nature. In this situation it is especially important to address the use of new technologies and their adequacy to given pedagogical objectives. The approach based on the idea of indiscriminate use of new information technologies has a strong negative effect on training students in both mathematics and new technologies. Considering the sixty percent share of mathematics disciplines in the curriculum, we consider this element of the concept to be highly important.

Professional Pedagogical education

The Russian system of training math teachers combines both professional mathematical and professional pedagogical education into one educational process. Professional pedagogical education includes the following components:

1. General psychological pedagogical education
2. Theory and practice of teaching mathematics
3. Preservice training

The first component is fundamental general psychological-pedagogical education. Disciplines such as pedagogy, general psychology, contemporary methods of pedagogy and psychology are included in the curriculum. In teaching general psychological-pedagogical courses, the students are introduced to the existing theories of the disciplines that relate to the specific aspects and psychological problems arising in the use of new technologies in education. In the course of study, the students acquire knowledge of the problems of using new technologies in psychological testing and data processing, medical _ physiological aspects, and general development problems.

The second component focuses on pedagogy and psychology with the emphasis on theory and practice of teaching a particular subject, such as mathematics. This component is reflected in the curriculum in such courses as psychological-pedagogical fundamentals of teaching mathematics, methods of teaching mathematics, methods of teaching computer science, elementary mathematics, and information technologies in education.

Different psychological theories are reviewed in the study of psychological-pedagogical fundamentals for teaching mathematics. First among these is that of the leading Russian psychologist, A. N. Leontyev, and researchers of his school, who are not very well known in the West (Leontyev, 1972). These theories can be used in developing methods and techniques for teaching of mathematics.

Presenting the material in different ways, solving motivation problems, methods of control, and traditional teaching with the use of information technologies are reviewed and demonstrated in these courses. The important factor is that exploring new technologies takes place in the context and framework of a specific subject methodology.

The course, *Methods of Teaching Computer Science*, deals with methodological problems of teaching computer science as a particular discipline. However, this course also develops better understanding of computer science by describing possibilities made available by new technologies. It also provides an opportunity to work with computers and use different types of software used in both educational and everyday settings. In courses teaching how to use new information technologies, the students are introduced to modern theoretical concepts for using technologies in education, psychological theories that provide successful use of information technologies, methods of teaching mathematics, and practical skills.

The course also deals with , in some detail, the history of using information technologies. But as a whole, it provides students with a good knowledge of modern psychology and pedagogy to help them cope with problems connected with the use of new technologies in classrooms. This course is aimed at systematizing and structuralizing and putting in a historical perspective, the material the students have studied.

Finally, the third component of professional training of a math teacher is training-on-the-job (preservice training or internship). In the process of the on-the-job training an adjustment of theoretical possibilities versus reality takes place. In five years of study at a teacher training institution, the students spend ten weeks in preservice training. It gives a supervising professor time to assess the students' professional skills in modern methods of teaching, including use of information technologies.

It is important to note that in the teacher training curriculum, twenty percent of course work is in general education. In general education courses, the students are introduced to word-processors, spreadsheets, and databases. General education courses also provide the opportunity for an instructor to introduce multimedia technologies in education to students.

The need to prepare students to use new technologies required some adjustments to the three part curriculum. First, a number of new disciplines were introduced and existing courses revised. The new disciplines come into the curriculum under the general title *Fundamentals of Computer Science and Information Technologies*. It is a series of courses taught during the first two years of education. Mathematics disciplines were also modified to include an introduction about new information technologies. Courses in the theory of algorithms, mathematical logic, and discreet mathematics were substantially extended. Some new courses; such as *Methods of Teaching Mathematics with Technologies* and *Teaching Methods of Informatics* were almost developed from scratch. New concepts of traditional software, such as the concept of educational databases, were also developed (Bouniaev, 1994).

In training math teachers, we proceeded from the assumption that instruction in fundamental math, psychology, pedagogy and methods of teaching math should precede study of disciplines immediately connected with information technologies. The priority of training in fundamentals over practical applications is common for training teachers of math and determines the order in which the disciplines are taught.

Thus, during the first two years, the top priority discipline is *Fundamentals of Computer Science and Information Technologies.* This provides fundamental theoretical knowledge and basic skills necessary to use computers in studying mathematical, psychological—pedagogical and general education disciplines. A sufficient level of theoretical knowledge of mathematics, psychology, pedagogy, and methods of teaching mathematics is reached after the first three years. Combined with the empirical experience acquired in using information technologies in studying the above mentioned courses, it makes it possible to proceed to detailed study of the course *Information Technologies in Education.*

We strongly believe that successful creative use of modern technologies is possible only with a high level of knowledge of a particular subject. In our case—math.

Conclusion

In conclusion, we will focus on some problems, the solution of which, could make a substantial impact on the quality of training teachers to use new information technologies. As already pointed out, further development of new technologies and their application affect the content of mathematics education. This leads to development of new methods of teaching which are inconceivable in a traditional environment, bringing about a number of psychological problems which unless recognized and dealt with, can lead to actually lowering the level of teaching mathematics. Determining the extent to which we change the content of education without seriously damaging the essence of the studied discipline is a problem of utmost importance. The greatest need right now is for a well developed experimentally tested psychological theory of training with the use of new technologies. In training math teachers to use information technologies, we proceed from the assumption that the teacher remains the key figure in organizing and carrying out the process of education. We consider the process of instruction to be management of learning activities. In this context, the issue arises as to which managerial functions can be turned over to the computer and which cannot.

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China: Impressions and Continuing Connections

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Great effort is being expended to make China a major world power in the next century. The tremendous building boom in Beijing and other major cities is unprecedented in all of China's history. Her opening to the outside world can be seen in the acceptance of Western-style clothing, joint ventures with international corporations, and the ubiquitous cafés, produce markets, and impromptu retail and bicycle repair shops to be found on every corner. Chinese educators applaud these changes and see a great need to revise their schools, curriculum, and instructional methods to meet the demands of modernization.

This paper will give a brief overview of the background and structure of K-12 education, the Chinese model for teacher education, the state of technology use in these schools; and will describe the enrichment of curricula and personal understanding through interpersonal contact with Chinese educators and students.

K-12 Education

Prior to the establishment of the People's Republic of China in 1949, 80% of the adult population (90% of the female population) was illiterate. One of the key aims of the Communist party was universal literacy — an admirable goal considering the vast size of the population and the number of calligraphic characters necessary for reading the most basic texts. Many innovative programs, such as winter schools for adult peasants, were established to meet this objective (Cleverley, 1991).

During the chaotic times of the Cultural Revolution (1966—1976), schools were virtually closed. The only safe curriculum was memorizing Mao's quotations or otherwise praising his deeds. Students were encouraged to doubt everyone, including their parents and teachers, and to create havoc by "Smashing the Four Olds:" Old Ideas, Old Culture, Old Customs, and Old Habits. Intellectuals were held in contempt and teachers unfairly persecuted for being "capitalistic" or "counter-revolutionary" (Yang & Lin, 1994).

In 1976, after Mao's death and the arrest of the Gang of Four, leaders within the Communist Party saw a need to rebuild the educational system. Reform efforts (CCPCC, 1979) directly relevant to this paper included establishing a policy of nine years compulsory education, encouraging the use of more diverse and effective teaching methods, and in preparing students to think independently so they could better serve a "strong and prosperous motherland." There were also efforts to increase the number of qualified teachers, to improve the quality of the teacher preparation programs, and the social status, living conditions, and wages of the nation's teaching force.

The Chinese school system today remains very centralized. A national curriculum is employed and schools throughout the country are organized into kindergartens (ages 3 - 6), elementary (grades 1 - 6), junior middle schools (grades 7 - 9), senior middle schools (grades 10 - 12), and universities or professional training institutions. At each level there are local, provincial, or national "key" schools which receive additional funding for faculty salaries, housing, and educational equipment and supplies. They can attract higher quality teachers and students. Entry into the higher level institutions, especially the key schools, is highly competitive, with many students vying for a relatively few openings.

During a two week visit in 1993, the author visited several key schools: from kindergarten through teacher education institutions. Being able to interact with the children made the kindergarten visit a special delight. The hallways and classrooms were decorated with brightly colored paper figures, including many Walt Disney characters, but the furnishings and items on display gave the school a 1950's "feel." The author saw no evidence of audiovisual technologies and the principal reported that the school did not have any computers.

The elementary school visited was a new facility with 960 students. The classrooms were stacked on four floors (with no elevator). The only decorations were posters of model Communist youths and heroes and classroom banners reminding the students to "Work hard, persevere." The classrooms consisted of wooden desks and chairs, a few paperbound textbooks, chalkboard, and a teacher's dais. Again, the classrooms had a 1950's aura, except for the fact that this school had a computer lab and teacher.

The lab consisted of 17 computer terminals. There were no disk drives or printers in the lab. A small separate room next door contained an early Apple II (not IIe, IIc, or IIgs) computer, three 5.25" disk drives, and a dot matrix printer. Only selected students were allowed to come into the computer lab. They received instruction on programming and how a computer works. The posted classroom rules were (as translated into English):

1. Wear your lab coat and put protective slippers on your shoes.
2. Leave all other materials out of the classroom.
3. Be quiet. Sit at your own desk. No walking around.
4. Do not play computer games.
5. Take care of your computer, no playing around.
6. Check your area before you leave. Make sure everything is in the right place.

The high school visited was one of 20 key senior middle schools in Beijing, with an enrollment of 1300 students in grades 10-12. Class sizes ranged from 45 - 50 students, with students attending school five and one-half days each week. After 3:00 P.M. each day the school offered extracurricular activities, including sports, art, and photography. Most teachers used the traditional lecture method (referred to by the Chinese as "cramming" or "feeding ducks"), but they are encouraged to try more "enlightened" methods. When asked if the curriculum had changed in response to the opening of China and the country's goals for economic development, the principal replied through his translator, "We're still working on that; trying to decide what to do."

The school's science and technology classrooms were located in a very modern-looking six-story building (again, no elevators). Each department had its own designated classrooms. The chemistry department, for example, had four laboratories and one large classroom for delivering lectures. The lecture hall seats were bolted onto terraced levels. There was a large chalkboard and two television monitors. Teachers in two different classrooms were observed utilizing videotaped programming.

There was a modern, technology-rich language lab and two computer laboratories. The principal proudly showed the school's new lab of 56 networked MS-DOS computers. These computers were acquired in 1992 through a school/university/corporate partnership. It appeared that the room is not used throughout the school day. Sophomores are brought in to learn how to use the computers and some content instruction is delivered through the medium, but the principal said that the lab was most often used for testing students from the university. When asked about the origin of the educational software, he said the teachers write it themselves.

The school also used an older Apple II clone laboratory. The laboratory consisted of 29 stand alone computers, a single printer, and a cabinet filled with 5.25" computer disks. Students in the room said that these computers were acquired in 1984 and were used for instruction in BASIC programming. This was corroborated by a BASIC programming routine printed on small chalkboard leaning against the wall.

Teacher Education

Teacher education in China is structured quite differently than in the United States. The amount of education required to be a teacher depends upon the grade level to be taught. For example, kindergarten teachers only receive three years of normal school training after completing a junior middle school program. Elementary school teachers are expected to complete junior middle school and three years of pedagogical training in a normal school. Junior middle school teachers are senior middle school (equivalent to the American high school) graduates and attend a two-three year professional college program. Senior middle school teachers complete a four year university program, with a major focus on their subject matter.

The author visited two institutions which prepare secondary teachers: Shaanxi Teachers' University and Beijing Normal University. Both are large, key universities in urban areas. Professors had overhead projectors in their classrooms and access to VCR's and television monitors. There were one or more computer laboratories on campus, but faculty did not have access to a computer in their offices. Computing courses were available, but not required, for all students. Computer science majors studied the inner workings of the machines and a variety of languages, including BASIC, FORTRAN, and C. Classes for non-majors covered applications topics such as wordprocessing and database management. Electronic mail was not generally available to faculty nor students, and no one with whom the author spoke was aware of hypermedia technologies.

Distance Learning. China takes advantage of televised delivery for teacher inservice and professional development. China TV Teachers College was created in 1985 to provide training to teachers who are working in poor, isolated areas and have not had access to higher education. The college offers courses appropriate for teachers working in elementary, junior middle, and senior middle schools. The courses are delivered via satellite transmission through two channels operating from 8:00 am to 9:30 P.M. each day. There are approximately 19,000 receiving stations. These stations tape the broadcast and distribute the tapes throughout the country.

Televised programming is geared to meet three needs: fundamental instruction for teachers currently working who do not have the required credentials, continuing education opportunities for teachers who are fully licensed, and coursework in educational administration for school principals. Textbooks accompany each of the programs so that students can preview and review the televised lessons. Interactive curriculum delivery via telephone, FAX, modem, or two-way video is not available.

When asked what assurances the government has that teachers are watching the programming, Mrs. Lu Xing, Vice-President of the college replied that the teachers are guaranteed time to study. Administrators must agree to give teachers a minimum of six hours per week release from classroom duties so that they can watch the programs. Classes are scheduled so that teachers have time to prepare for examinations during their semester breaks. China TV Teachers College's three-year curriculum (for elementary and middle school teachers) can be taught in a four year period, while the secondary teacher's four year curriculum is taught in five.

Interpersonal Contacts

The highlight of any trip is not the sights, but the people encountered. The Chinese were most gracious hosts. They exhibited a great deal of interest in Western curriculum and instructional methods and were particularly eager to learn more about technological advances in education.

The prevalent Chinese model for computers in schools is to set up computer laboratories in which select students can learn how to use a computer, learn some programming or more "practical" skills such as wordprocessing, and, in some cases, work with content-related software developed by their teachers. The notion of a one-computer classroom was totally foreign to them. Most had never heard of multimedia, bar codes, Logo, or HyperCard, and many were new to simulation software and computer-based telecommunications. Many questions were asked about the number of teachers capable of using computers, how they manage their classrooms, the development of technology-based instructional materials, and the cost of hardware and software.

The contacts established in China have continued into the United States. Two young people met during the China visit have come to study at the author's institution. One of the students, Mr. Feng Sun, held an administrative position with the Shaanxi Educational Commission. The other, Miss Yi Qing, was an instructor of English at Beijing University of Posts and Telecommunications. Both are pursuing master's degrees in curriculum and instruction, with Miss Yi focusing her studies on the educational applications of computer-based technologies.

Two professors, Drs. Lin Bing and Yang Zhiling, from Beijing Normal University are lecturing at the author's campus. They are teaching a variety of courses, including *Comparative Education*, *Women in Chinese Society*, *Calligraphy*, and *Tai Chi*. They also serve as guest lecturers for a large number of K-12 and teacher education classes.

These four people are tremendous assets to the school's educational program. Their participation in and delivering of classes and guest lecturing activities have greatly enhanced the curriculum. They also have been instrumental in helping arrange exchange visits with other Chinese educators. Getting to know these people on a personal level has helped faculty and students see the universality of the human condition while appreciating the differences between American and Chinese ways. Equally important, having four people, with four distinct backgrounds and personalities, arrive simultaneously has helped prevent the formation of naive stereotypes regarding Chinese behavior and ideas.

Implications for Technology-Using Educators

There is a great interest in China in educational technology and teacher education reform. The theme of economic development through technology and education arose in several conference sessions and in multiple private conversations. During his keynote speech, Professor Gu Mingyuan, Graduate Dean of Beijing Normal University noted,

> The 21st century will be a century of science and technology. The content and methods of teaching will be greatly changed. Teacher education must adapt to these changes. Teacher education is the engine for the advancement of the whole education system. The quality of teacher education has a direct impact on secondary education and on the quality of human resources . . . It must be geared to the future needs [and] development of science and technology and reform its teaching content and methods in order to prepare highly qualified secondary school teachers."(1993, p. 2)

While the Chinese are concerned about the societal impact of new ideas and economic development, they are very interested in importing new technologies and learning from Western educators. It would be arrogant to assume that we Westerners have "the answers" and should directly import our ideas on other cultures. It is, however, acceptable to present what we know and allow our Eastern colleagues to select what best fits their culture and society.

The USA/Sino Teacher Educational Consortium, a loosely connected group of colleges and universities from throughout the United States and Pacific Rim, is the organizing body for the activities described within this paper. The author would like to encourage other teacher educators to continue and expand these exchanges. We have so much to learn from each other.

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Development and Dissemination of the First Major CMI System for Chinese Schools

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As we are racing along the Information Super Highway and becoming fascinated by the increasingly amazing educational software, has one ever wondered how this wonderful, yet expensive, technology can be disseminated efficiently in developing countries such as China that claims 177 million school students (SECPRC, 1993)? Speaking a unique language and operating with an educational budget of less than 3% of the Gross National Product, the Chinese educators can neither buy nor use most of the educational software on the world market. Consequently, catching the Magic School Bus along the Information Super Highway appears to be a formidable dilemma for Chinese educators.

To meet the challenge of the Information Age, the Chinese educators and software engineers created their own experience. With limited resources, the Chinese went into the managerial system of the school administration. The Clever Software Company (CSC) in Beijing developed in 1991 the CSC *Principal's Management System* (CSC System) that was hailed as the first major computer managed instructional/administrative (CMI) system for Chinese schools (Wang & Lin, 1994). The development and dissemination of this System created an efficient Chinese model of technology diffusion. This model might offer ideas to other developing countries.

This paper addresses the development and dissemination of the CSC System under four subheadings:

1. Development of CSC System, which explores the development of this system from its embryo to the present 6.0 version and places the development of this software into the unique context of China;
2. Major characteristics of the System, which include major components, designing principles, system structures, and other major features;
3. Dissemination strategies, which describe strategic planning, massive training, and promotion strategies;
4. New challenges, which reflect the development and dissemination processes.

Development of the CSC System

Excited by the global technology explosion and, at the same time, frustrated by the inequality of technology diffusion among schools in different parts of the world, a group of graduates from an elite Chinese university took on the challenge of massively disseminating computer technology to Chinese schools in 1991. Disseminating technology on a massive scale involved expertise and high cost. A developing country such as China was typically short of both. After carefully analyzing the available software in the Chinese language, limited school budgets, and the existing paradigms of Chinese teachers and administrators, these young scientists from the CSC decided to create a major software system that would combine computer managed school administration with computer aided instruction. The final product of their efforts was the 1.0 version of The CSC Principal's Management System, which was subdivided into Elementary, and Secondary School versions.

The CSC System is organized under 3 major principles: efficiency, collaboration, and standardization.

Efficiency. If any principals were pushing papers and struggling with forms, the administrators in China were certainly among the most frustrated due to the nature of a centralized managerial system. This CSC System aimed at simplifying a routine process in a timesaving fashion, and alleviating much of its mechanical workload with a computerized system.

Collaboration. The collaboration among educational organizations, expert teachers, and software engineers was essential in developing educational software. Therefore, the Center for Educational Research of CSC was established in 1993. Its faculty consisted mainly of retired expert teachers, senior faculty and researchers from educational institutions in Beijing. The number of its staff grew to 45 in 1994. These expert teachers masterminded the Testbank of the CSC System, and assured that all items were accurate and aligned to the National Curriculum Guidelines. At the Center, these teachers were further divided into discipline areas to initiate or supervise each process. For instance, the Math Testbank was scrutinized by a team of expert teachers headed by Mr. Zhou Peigeng, a star math teacher in China, whose students had won multiple gold and silver medals in International Math Olympics (Wang & Lin, 1994).

Standardization. Despite all the criticism associated with a centralized educational system, the centralized Chinese educational system actually made a standardized management system easier. The benefits of the standardized management system were, curriculum standards, staff salary scales, and information networking at different organizational levels. The new project the CSC initiated in collaboration with the Chinese Educational Commission was to develop a system that will connect administration at School, County/District, City/Province levels with the National Educational Commission in Beijing.

Today the Clever Software Company has grown into the largest educational software company in China with a full time staff of 312. Over half have earned MA or Ph.D. degrees from major Chinese universities. The CSC has just released the 6.0 network version of the CSC System. The new products they are developing include the *CSC Education Database, Electronic Family Tutor, Multiple Electronic Classroom, Local Networks,* and *Education Consultation Service.*

Major Characteristics of the CSC System

The CSC Principal's Management System consists of 8 major sections including Education Administration, Testbank, Education Database, File Management, Wordprocessing, Graphics, Telecommunication, and System Operation. Each section is subdivided into multiple functions that provide various services. The flowchart of the CSC System is found on the following page.

One of the major characteristics of the CSC System is a well-designed and frequently revised Testbank for the administrative system. The CSC designers understood that no major computer managed administrative software could sell well in China without a comprehensive Testbank, because testing was one of the most important components in Chinese school curricula. Chinese students were studying in such a competitive mode, that designing and selecting appropriate tests often consumed much of the workload of teachers and administrators. Therefore, great emphasis was given to the construction of a testbank that followed strict rules. For instance, the items selected for each testing category must meet the following criteria: a) Each item must be scientifically correct; b) Each item should draw clear- cut answers, and these responses must be applicable to most of the related fields; c) All items must follow the Guidelines of the Curriculum Standards stipulated by the National Educational Commission; and d) All items need to be written in a standardized format (Han, 1993).

Periodic revision is part of the development process. From December 1993 to March 1994, the Testbank underwent a major revision. Forty-five full time and fifteen part time expert teachers scrutinized 120,000 test items and added 20,000 new items. The revised Testbank was able to facilitate customized Unit, Midterm, Final, Graduation, Selection Tests, and was realigned to the new Curriculum Standards (Wang, 1994).

Dissemination Strategies

Disseminating the CSC System to a population that was not familiar with computer-aided management and instruction was as much a challenge as developing the software itself. Therefore, great efforts were devoted to outreach programs. The dissemination of the CSC System was carried out by five strategies: hands-on advertising, massive training, after-sale service, financial support, and reward systems.

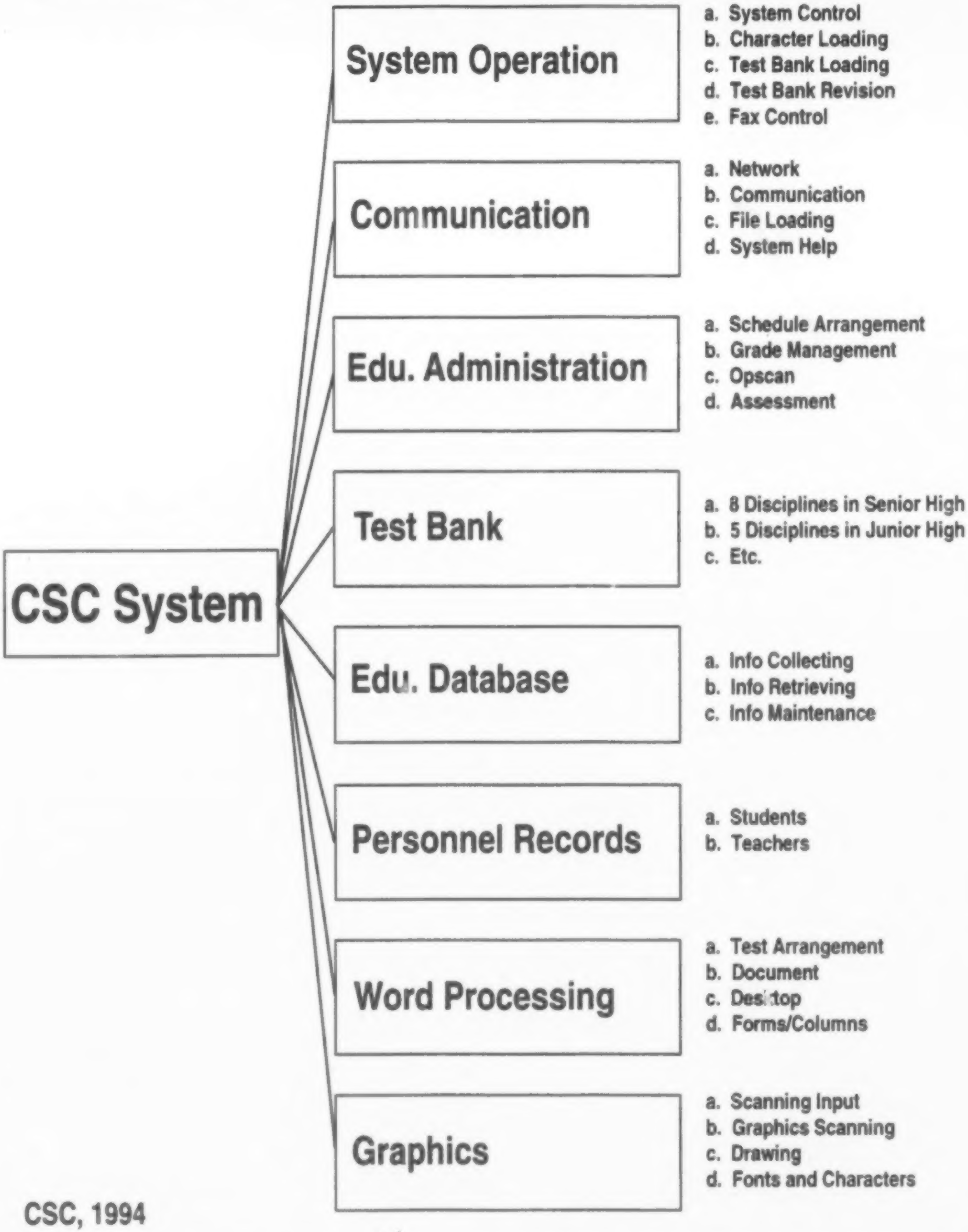
Computer aided management and instruction was a new phenomenon in Chinese schools. Many teachers and administrators had not touched computers before buying this system. They were often shocked by its price tags. They needed to see how well this system would work, and balance its efficiency with the school budget. To this effect, the Clever Software Company staged a series of computer shows and hands-on fairs across the country. They invited principals from all over the country to attend training at strategically located cities and provided them with various hands-on experiences.

The Training Center at the CSC Home Office provided free and hands-on experiences for teachers and administrators. These workshops were open three times a month to any teacher or administrator with an ID card. Various workshops were also provided at selected magnet schools in thirty cities in China. Last summer, the writer walked into one of the training workshops in the CSC Shanghai Branch Office to find out what programs were offered there. At that session, the training started off with an overall introduction about the System, followed by descriptions of each component, a crash course on DOS, the usage of Chinese Card, and a hands-on experience with the System. The facilitators then made themselves available for questions and business transactions. The CSC also offered a thirty sessions TV lecture program, and a separate correspondence course for teachers and principals nationwide.

The after the sale service included free repair and free updating of higher versions of the software. The CSC

Table 1.

Structure of the CSC System


CSC System
System Operation
a. System Control
b. Character Loading
c. Test Bank Loading
d. Test Bank Revision
e. Fax Control
Communication
a. Network
b. Communication
c. File Loading
d. System Help
Edu. Administration
a. Schedule Arrangement
b. Grade Management
c. Opscan
d. Assessment
Test Bank
a. 8 Disciplines in Senior High
b. 5 Disciplines in Junior High
c. Etc.
Edu. Database
a. Info Collecting
b. Info Retrieving
c. Info Maintenance
Personnel Records
a. Students
b. Teachers
Word Processing
a. Test Arrangement
b. Document
c. Desktop
d. Forms/Columns
Graphics
a. Scanning Input
b. Graphics Scanning
c. Drawing
d. Fonts and Characters

CSC, 1994

Newsletter published by the Company systematically answered some of the user questions. For some of the remote areas, limited financial help was available. By 1994 the company had given away 820 computers with the CSC System and in 1993 donated a gift set to the Tibet Secondary School. At the Jingfeng Hotel Exhibit this year, representatives from 7 schools in Tibet came to buy the System. (There are altogether 71 schools in Tibet.)

Realizing that disseminating computer technology to 177 million students would involve great efforts of the whole society, the CSC established the Chinese Computer Education Fund of 300,000 Yuan ($34,500) in May of 1994. The purpose was to reward those who would make substantial contributions to computer-related education. The fund was provided by the CSC annually and managed by the National Educational Commission in Beijing (Hong, 1994).

As a result of all these efforts; one fourth of schools in Beijing, one tenth of schools in Tibet, and many other schools across the Country had purchased the CSC systems (Sun, 1994, & Guangming Editor, 1994). It was announced at the founding of the Association of Computer Education in Elementary and Secondary Schools last May that over 3,000 schools nationwide were using this CMI system.

New Challenges

According to Mr. Song Chaodi, President of the CSC, the success of the CSC experiences can be attributed to the following 5 approaches: Efficiency oriented step-progressing mechanism; collaboration among educational organizations, expert teachers and software engineers; standardized procedures; paradigm shift in educational philosophies, and support of a large contingent of educators (Song, 1994).

The Clever Software Company explored the available resources in China. Instead of avoiding a bureaucratic authority of the National Educational Commission, tapped its resources. They found common interests between the Government and CSC, and established common goals of popularizing computer education for the benefit of all people in China.

Today more than 9,000 of China's 800,000 elementary and secondary schools are equipped with 120,000 computers. About 4,000 elementary and secondary schools are using computer managed administrative and instructional systems. About 10,000 computer teachers, and 4,000,000 elementary and secondary school students had completed some amount of computer training (Wang, 1994).

Among the 4,000 computer managed administrative and instructional systems currently used in Chinese schools, over 3,000 are the CSC System. Notwithstanding 3,000 out 800,000 schools is a tiny sprinkle of water in the Chinese Sea. Yet, this represents a growing spring in a developing country. In fact, computer-facilitated education is growing so fast in China, that the numbers of computers in schools are increasing exponentially. Considering what schools were like electronically in China just five years ago and the available school budget for electronic equipment, the impact of CSC System on modernizing school administration and instruction in China has been remarkable.

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A Cross-Cultural Comparison of Computer Attitudes among Preservice Teachers

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With microcomputers widely used in educational settings, it is important to address the student attitudes toward computers, especially for students who are preparing to be teachers. Many studies have examined students' attitudes toward computers at varied school levels (e.g., Campbell, 1989; Campbell & Perry,1989; Chen, 1986; Collis & Williams, 1987; Loyd & Gressard, 1984; 1986; Loyd & Loyd, 1988) which report that factors such as gender and prior computer experience may influence students' attitude, anxiety, and confidence in using computers. In recent years, there are a few studies which have examined computer attitudes for preservice teachers. Koohang's (1987) study of 60 preservice teachers found the amount and nature of computer experiences to be two major factors that influenced preservice teachers' attitudes toward computers.

Cross-cultural comparison of attitudes toward computers is an area that has recently been noticed but in which more research is needed. A study conducted by Collis and Williams (1987) found Chinese high school students were more positive in their attitudes toward computers when compared to Canadian students. (Also, there were fewer gender differences among Chinese students in attitudes toward computers.) Marcoulides and Wang (1990) used two samples of college students from Los Angeles, California, and Hunan, People's Republic of China to examine attitudes toward computers. They reported that computer anxiety was present to a similar degree in both samples. However, very little research has been conducted comparing the computer attitudes among preservice teachers in America and Taiwan.

The major purpose of the present study was to identify the effects of different cultural backgrounds on preservice teachers' attitudes toward computers. More specifically, the study attempted to examine the effects of (a) country (i.e., America and Taiwan), (b) gender (male and female), (c) computer experience (i.e., 0-6 months, 6-24 months, and more than 2 years) on preservice teachers' attitudes toward computers.

Method

Subjects

A total of 419 education majors participated in the present study. Two samples were identified. The first sample contained 116 American undergraduate students fom two state-supported public universities located in a major metropolitan city in the Southwest. The second sample contained 303 Taiwan college students from a national teachers college located in Taipei, Taiwan, Republic of China. Although the subjects in both countries were from various fields in education, it should be noted that the American sample is skewed as to gender and the Taiwan sample is more than twice as large as the American. Table 1 presents the demographic data of the subjects.

Instrument

The instrument used for the present study was the Computer Attitude Scale (CAS) (Loyd & Gressard, 1984), which consists of 30 Likert-scale type of questions divided into three ten-item subscales: computer anxiety, computer confidence, and computer liking. The scores were computed for each student; one score for each of the three subscales. Higher scores on the computer anxiety subscale correspond to lower anxiety, while higher scores on the computer confidence and liking corresponding to higher confidence and liking. The instrument has been previously used with students at varied school levels (Loyd & Gressard, 1984; Loyd & Gressard, 1986; Loyd & Loyd, 1988; Massoud, 1990; Massoud, 1991).

The instrument was translated into Chinese for the purpose of administering the CAS to subjects in Taiwan. Every attempt was made to provided a Chinese version that was as faithful a representation of the English as possible. Once the Chinese version (CCAS) was prepared, two Chinese colleagues, both from the English Department, verified the instrument and compared it to the English version. A few minor changes in the Chinese wording resulted in the final version of the CCAS.

Procedures

Subjects were administered the CAS separately. All American participants completed the CAS near the end of the Fall academic semester, 1990. The subjects in Taiwan were administered the CCAS at the beginning of the Spring academic semester, 1992.

Data Analysis

To examine the nature of these computer attitudes means and standard deviations were computed for each of the three scores. In addition, a series of 2 x 2 x 3 factorial analysis of variance (ANOVA) procedures were performed to identify any statistically significant differences among: a) country (i.e., America and Taiwan), b) gender (i.e., male and female), c) computer experiences (i.e., 0-6 months, 6-24 months, and more than 2 years), and (d) significant interaction effects among these three factors. Three such 2 X 2 X 3 factorial ANOVA procedures were completed which corresponded to the three subscales of the CAS.

Results

Table 2 shows the means and standard deviations for country, gender, and computer experience. The total scores were ranging from 26.3 to 29.1 on a 40-point scale.

Summaries of the three 2 X 2 X 3 ANOVA procedures are presented in Table 3. The results of the ANOVA procedures indicate a significant effect for computer experience on all three subscales. The effect of gender was statistically significant only for computer liking. Statistically significant interactions were found on country by gender for computer confidence and liking. A statistically significant interaction was also obtained on country by computer experience for computer liking.

The results of the first ANOVA, using computer anxiety as the dependent variable, indicated that only computer experience was statistically significant. The results of the post hoc (Scheffe's F) test showed that subjects who had more than 2 years of computer experience scored significantly higher than subjects with 0-6 and 6-24 months of computer experience. Students with less than 2 years of computer experience were significantly more anxious about computers than those who had more than 2 years of computer experience.

Table 2.
Means and Standard Deviations of Anxiety, Confidence, and Liking by Country, Gender, and Computer Experience

	Variables	Anxiety	Confidence	Liking	Total
Country					
American	X	27.345[a]	28.888	27.793	28.009
(N = 116)	SD	6.054	4.512	5.565	4.746
Taiwan	X	26.970	26.673	26.756	26.800
(N = 303)	SD	4.770	4.007	3.149	3.472
Gender					
Male	X	27.580	27.516	27.025	27.374
(N = 157)	SD	5.307	4.272	3.835	3.853
Female	X	26.771	27.149	27.053	26.991
(N = 262)	SD	5.043	4.262	4.083	3.926
Computer experience					
0-6 months	X	25.571	26.503	26.810	26.295
(N = 147)	SD	5.349	3.925	4.607	4.053
6-24 months	X	26.623	26.497	26.528	26.549
(N = 159)	SD	4.096	3.747	2.899	3.028
more than	X	29.664	29.416	28.071	29.050
2 years	SD	5.299	4.661	4.278	4.156
(N = 113)					

Note. Maximum possible score for each subscale is 40.

The results of the second 2 X 2 X 3 factorial ANOVA, using computer confidence as the dependent variable, indicated a significant effect for computer experience and a significant interaction for country by gender. The results of the post hoc test showed again that subjects who had more than 2 years of computer experience scored significantly higher than subjects with 0-6 and 6-24 months of computer experience, suggesting that students with more than 2 years of computer experience were more confident than those with less than 2 years of computer experience. The follow-up analysis for the significant interaction effect (see Table 4) indicated that female American subjects scored significantly higher than all subjects in Taiwan; also male Taiwan subjects had significantly higher scores than female Taiwan subjects.

The results of the third ANOVA, using computer liking as the dependent variable, indicated two significant main effects (one for gender and the other for computer experience) and two significant interactions (one for country by gender and the other for country by computer experience). The results of the significant main effect for gender showed that female subjects scored significantly higher than male subjects. However, because the means for male and female subjects were quite close (male = 27.025 and female = 27.053) one-way ANOVA using gender as an independent

Table 3.
Summaries of Three-way ANOVAs for Anxiety, Confidence, and Liki

Source	df	MS	F
Anxiety			
Country (C)	1	17.714	.722
Gender (G)	1	.763	.033
Computer Experience (E)	2	375.516	16.374***
C x G	1	70.103	3.057
C x E	2	61.531	2.683
G x E	2	22.365	.975
C x G x E	2	6.492	
Error	407	22.934	
Confidence			
Country	1	2.493	.166
Gender	1	8.019	.534
Computer Experience	2	86.64	5.771**
C x G	1	165.35	11.013**
C x E	2	1.252	.083
G x E	2	24.718	1.646
C x G x E	2	41.266	2.749
Error	407	15.014	
Liking			
Country	1	19.112	1.315
Gender	1	62.119	4.273*
Computer Experience	2	75.009	5.16**
C x G	1	171.135	11.772***
C x E	2	64.866	4.462*
G x E	2	10.341	.711
C x G x E	2	6.324	.435
Error	407	14.537	

* P < .05 ** P < .01 *** P < .001

variable was performed. The results showed that there were no significant differences between female and male subjects (F(1,418) = .005, p>.05). Therefore, the significant effect for gender showed in the three-way ANOVA may result from the significant interaction between country and gender. The results of the post hoc test for computer experience showed that subjects who had more than 2 years of computer experience scored significantly higher than subjects with 0-6 and 6-24 months of computer experience. The follow-up analysis for the significant interaction between country and gender showed that female American and male Taiwan subjects had significantly higher scores than male American subjects; in addition, female American subjects scored significantly higher than female Taiwan female subjects.

Table 4.
Means of Confidence Scores by Country and Gender

	Country		
Gender	American	Taiwan	Total
Male	26.727a (N = 11)	27.575 (N = 146)	27.516 (N = 157)
Female	29.114 (N = 105)	25.834 (N = 157)	27.149 (N = 262)
Total	28.888 (N = 116)	26.673 (N = 303)	27.286 (N = 419)

Note. Maximum possible score is 40.

For the significant interaction between country and computer experience, the follow-up analysis showed that American subjects with more than 2 years of computer experience had significantly higher scores than American subjects who had 0-6 months computer experience; also American subjects with more than 2 years of computer experience scored significantly higher than Taiwan subjects who had 6-24 months of computer experience. All significant interactions are presented in Figure 1.

Discussion

The major purpose of the present study was to examine the effects of different cultural backgrounds on preservice teachers' attitudes toward computers. The results suggest that students, in general, had slightly positive attitudes toward computers.

Computer experience was observed to be a major factor in all three computer attitude subscales, with increasing computer experience corresponding to more positive attitudes toward computers. The findings were consistent with previous research (Koohang, 1987; Liao, 1993; Loyd & Gressard, 1984; Loyd & Loyd, 1988; Marcoulides, 1988). The significant interaction between computer experience and country for computer liking suggests that there was some degrees of variance between preservice teachers in America and Taiwan for this trend. However, without control of the nature of these computer experiences, it is not possible to determine whether longer exposures of computers directly cause more positive attitudes toward computers.

The findings of significant interactions between country and gender for computer confidence and liking indicate that gender differences in attitudes toward computers exist only for Taiwan preservice teachers, in which male subjects showed higher confidence and liking in use of computers than females. Collis and Williams (1987) in a study reported that there were fewer gender differences among Chinese students in attitudes toward their computers. Obviously, the results of the present study do not agree with their findings. A possible explanation for this is that

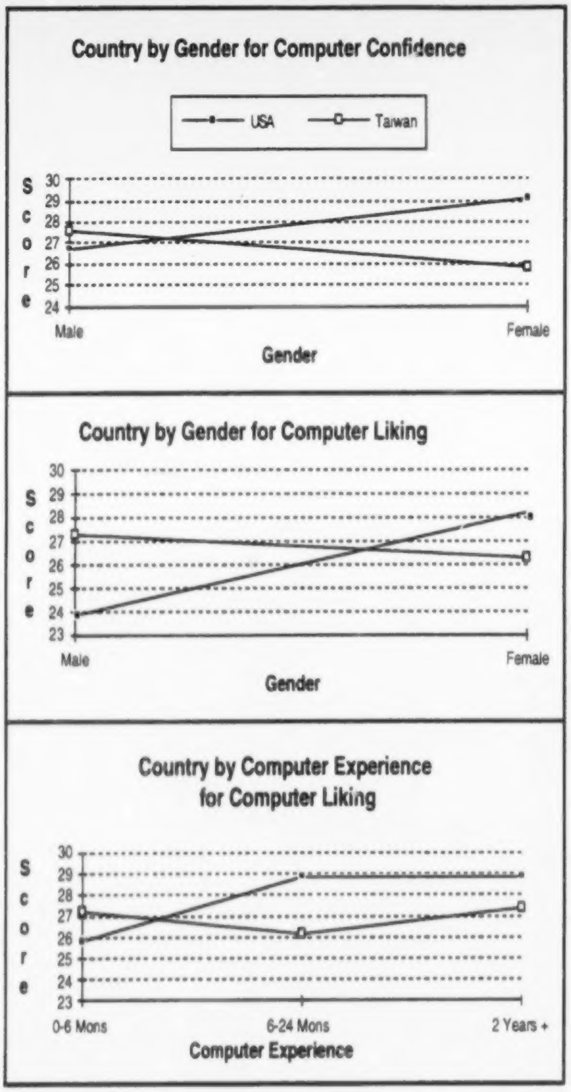

Figure 1. Significant Interactions between Variables

students in Taiwan are strongly affected by society's reinforcement of sexual stereotypes. This cultural bias may therefore result in gender differences in attitudes toward computers when the computer has been viewed as a male domain. The study by Collis and Williams (1987) did not use subjects in Taiwan and may therefore resulted in different outcomes.

The significant differences observed in computer liking for American female subjects over male subjects were a great surprise. Some previous studies have found that males students scored significantly higher over females on some computer attitude scales (Griffin, Gillis, & Brown, 1986; Hattie & Fitzgerald, 1987; Martinez & Mead, 1988); other studies reported no significant differences (Colbourn & Light, 1987; Eastman & Krendl, 1987; Johnson, Johnson, & Stanne, 1985; Kay, 1989; Krendl, Broihier, & Fleetwood, 1989; Loyd & Loyd, 1988; Pulos & Fisher, 1985; Richard, Johnson, & Johnson, 1986; Smith, 1987; Swadener & Hannafin, 1987). Very few studies reported an opposite result, in which female subjects were superior to male subjects. However, given the limitations of uneven cell sizes (i.e., n of female = 105, n of male = 11), the result should not be overgeneralized.

Although the results from the present study might be limited by the size and representativeness of the samples with regard to the population of preservice teachers in America and Taiwan, the results are valuable. Not only did the study examine and compare the presence of computer attitudes in the context of two different cultural backgrounds, it also provided useful information about preservice teachers' reactions toward computers in Taiwan. Since previous studies have identified significant relationships between computer attitudes and computer achievement (Dambrot, Watkins-Malek, Silling, Marshall, and Garver, 1985; Mercoulides; 1988; Wiggins, 1984), there is a reason to believe increasing students' positive attitudes toward computers may help students in the learning process. Computers have become one of the most useful technologys in educational settings in America, and are growing worldwide. Therefore, the understanding of computer attitudes for peoples of different cultural backgrounds may serve as a valuable resource for researchers and practitioners in America. American practitioners can understand factors that may influence computer achievement for students in other countries.

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Experiences in the Development, Dissemination & Use of Computer Based Materials in India

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MORE INFO
ON CD-ROM

Training methods and media change with successive developments in technology. Each new technique which thus emerges competes for the attention of training managers, teachers, and learners. The most widely adopted technique is computer-based-training (CBT) enhanced with a variety of peripherals and software. Within this approach multimedia work stations, with a wide array of video cameras, scanners, microphones and sound blasters, CD-ROMS, touch screens, graphics, and animation are used to create a new platform for self-paced learning. These new technologies, when coupled with LCD panels and video projectors provide a new way to deliver group presentations. The days of slide projectors and *Epidiascopes and the associated skills of preparing them are gone. Emerging technologies demand new sets of skills for both preparation and presentation.

Trends Causing Demand for Computer Based Training Materials in India

Computer Based Training (CBT), called Computer Assisted Instruction (CAI) in education, has become much in demand in India at all levels: Arts & Science colleges, polytechnics, engineering institutions, and industrial training centres. In part, this is due to the capability and power of personal computers and their widespread acceptance in educational institutions as well as the current popularity of CAI approaches.

Trends in Computer Education in Indian Schools

Indian parents are very much concerned with computer education for their children, starting with primary classes. In 1985, the government initiated the CLASS project which used limited aid from the UK and a large investment by the Indian government to supply BBC computers to selected schools. Additionally the government created a public sector company to manufacture the computers indigenously and adopted Nodal centres to train teachers and to provide support for the CLASS Project.

The goal of the CLASS Project was to target computer literacy and create computer awareness for school children. The BBC computers had computer games and a few accompanying CAI lessons. This eight bit proprietary computer ran only customized software and as a result, many local private software firms began to develop and market a large number of CAI lessons. Though a considerable amount of CAI packages were made available, the project failed due to a) the popularity of IBM/PCs, b) private schools were not covered by the government under the project, therefore opting for IBM/PCs rather than BBC micros, and c) administration tended to insist on test and examination which curbed the original purpose and aim of the CLASS Project.

Schools, particularly in the cities, have since acquired a large number of IBM/PC clones and provide four to six hours of weekly computer instruction and practice as part of the curriculum. With IBM/PCs in position and with the curriculum containing BASIC and IBM/PC utilities, the trend began to stress programming skills, though this was not the idea of the CLASS Project. Since the Post Secondary Curriculum emphasized programming, the schools voluntarily introduced and taught programming. The computer curriculum is primarily focused on teaching BASIC programming. Schools currently offer computer practice, starting with the primary classes, charging high fees, while software companies have stopped developing CAI packages for BBC computers.

Schools are now looking for CAI packages and computer games that can run under DOS on the IBM/PCs. Although there is no government effort underway to produce and provide CAI packages for the IBM/PCs, schools are attempting to use public domain software and games to fill the computer curriculum. Some of this void is filled by private software vendors who are marketing limited CAI packages on English, Maths, Physics, Chemistry and Biology for use in upper primary and lower secondary classes. There is a great need for a larger and more systematic development of IBM/PC CAI packages for the school level and a need to integrate them with traditional lectures and laboratory classes.

Trends in Computer Education in Polytechnics

Computer facilities are only found in the Computer Science departments in the Polytechnic schools. Other departments generally do not have use of computers for their students and staff. These institutions, to a limited extent, use online software manuals for computer subjects. Practically no CBT is in use for other subjects. The students' class schedule does not provide any free periods of study for library or laboratory work with self paced computer based training materials. Because of limited computers in the lab, computer based instructions will be introduced in the lab cycle.

Technical Teachers Training Institute role in the Development of CBT materials.

Training the Faculty of Teachers College

In May 1988, Technical Teachers Training Institute (TTTI) conducted a three week training program for twenty selected teachers from training colleges located in Madras. These teachers had a basic science degree but no prior knowledge of computers. GW BASIC, Story Board, and CBT design formed the core of the course. The participants were paired for each topic so that they could mutually consult and jointly develop the CBT. The topics and content were prescribed such that 25 minutes of CBT could be developed and finished within the training course time. The topics for CBT projects were selected to cover a variety of lessons and school subjects. The CBT lessons developed came from the natural sciences and covered the gamut from biology to physics.

During development, the contents of all frames, including test and feedback, were checked closely and scrutinized by the content experts with necessary corrections made immediately. The lessons were reviewed by other participants with feedback as an ongoing activity during the course. Later, teachers from schools teaching the respective subjects were invited to review the lessons with their comments being incorporated into the work. These finished lessons were supplied to select schools for use by students. Implementation problems, different but otherwise plausible answers to questions, average time taken, and scores on post-tests were obtained from the classrooms.

For Polytechnics: A Trainee Program

Development of CBT packages on selected technical topics useful to Polytechnic Education and computer education was accomplished through a trainee program. Choice of the programming language was made on the basis of interest, level of programming skill with various authoring and programming languages, and the need and suitability of the topic for experimentation. The size of the package was not restricted since the coverage was to be comprehensive. The packages were programmed using C, PROLOG and QUEST. Apart from GW BASIC, the topics covered were menu driven. Notable among them are: *TV Servicing, Microprocessors, Digital Gates, and Automobile Electrical Circuits.*

Using the project trainee program, the Computer Centre developed CBT packages for teaching all computer languages and IBM/PC utilities. The first set of packages is now ready for release. The supplement in reference 2 to this paper provides full details of the packages. The packages developed are: *Personal Computers, DOS, BASIC Programming, BASIC Graphics, C Programming, COBOL Programming LOTUS 123, WordStar, dBASE III PLUS, AUTOCAD, PC Fault Diagnosis, PC Tools.*

Management Development Training

The Computer Centre at TTTI conducted a global survey to find computer hardware to support a laser disk computer-based interactive video (CBIV) Systems for management development training. Finally, in March, 1990, 12 CBIV stations with IBM INFO WINDOW were ordered from M/s. Allen Communication USA. The laser discs were obtained from Applied Learning International (ALI) USA . The management topics consisted of a series of 10 laser discs. Each one covered one of the management development skills topics of the Wilson Learning Systems USA; such as *Perception, Decision Making, Decisiveness, Oral & Written Communication, Interpersonal Relationship, Control & Follow up, Flexibility, Organizing & Planning and Leadership.* Computer topics were on *dBASE, WordStar and Lotus 123.*

TTTI has integrated a large number of CBIV management development courses into traditional training methods. The subsequent transfer of skills to actual job situations was facilitated by participant discussions and written responses in the workbook exercises which accompanied the disks. The participants were very enthusiastic about the self-paced learning with private responses. The final practice provided proved to be very helpful for retention and application. TTTI is currently providing open access to the CBIV for all management personnel in various local industries with a charge for using the disks.

Factors Influencing the Success of Developing and Using CBT packages

Based on the experience of various projects and schemes undertaken by the Computer Centre for effective development and use of CBT; the following are found to be the successful factors:

1. selection of suitable areas of application
2. criteria for selection of topics and of available CBT
3. planning the interactive lessons,
4. selection of authoring and programming languages
5. methods of evaluation
6. documentation
7. team work.

Future Projects

Most of the CBT produced contains linear and sequential frames similar to what Robert Skinner advocated. Branching has been incorporated in some of the packages by the use of multiple choice questions and appropriate treatment of the responses.

In future projects, branching techniques, as in CBIV, is planned. Additional work on development of Intelligent CAI (ICAI) is also planned. CD-ROM information is now being made available in the country by private agencies. Indian National Scientific Documents Centre (INSDOC) New Delhi. A GOI organization, working under the Council of Scientific and Industrial Research (CSIR), is providing accessibility through computer networks within the country through Educational Research Network (ERNET). Thanks to DOE support it also provides e-mail facility through Global Gateways to BITNET, INTERNET, and DIALOG. Computer Centre will be setting up an E-mail facility during January/February 1995 and will be able to access international databases. Computer Centre is also planning to develop sample CBIV packages in collaboration with the R & D of Computer Maintenance Corporation (CMC), India.

Because of TTTI, India has well established production facilities for Educational Television (ETV). One of the divisions of National Centre for Software Technology (NCST) Pune, Bombay, which is working on an application of Artificial Intelligence and expert system for CAI. TTTI is planning to collaborate with them in these emerging areas. TTTI has acquired add-on cards for existing IBM/PCs and plans to use them for multimedia projects. Another project, for the add-on audio cards, is under consideration to explore the possibility of low cost audio systems to enhance dumb CBT materials. Computer Centre will be launching a project to release all the tested packages to all schools, polytechnics and other institutions at bulk cost through UGC, NCERT, DTEs, and Director of School Education, which will lead to a thrust for CBT throughout the whole country.

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Technology, Problem Solving and Gender Issues: A Focus For Teacher Change

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As computers become a part of our society, more emphasis is placed on their use in schools. With the incorporation of reform documents oriented toward the 21st century (i.e., NCTM Curriculum and Evaluation Standards, and Goals 2000) more demands are placed on teachers in school situations. These documents require increased use of technology and equality for all in relation to areas not usually considered female domains. The visions of these documents require a new awareness for teachers of issues that deal with problem solving, technology and gender.

Goals 2000 and the NCTM Curriculum and Evaluation Standards (1988) call for dynamic changes in education. They call for setting high standards for every child in preparing them with the knowledge and skills needed for the complex jobs of the 21st century. These school reform efforts require the improvement of teacher training in technologies to achieve the high standards described in the documents. Too few students are being prepared for the challenges of the 21st century. Students, especially minority groups, including females, are leaving school without the skills and tools they need to prepare them properly. Differences in participation between males and females continue to be observed in higher-order, more intensive mathematics courses and applied fields (Leder, 1992).

Teacher beliefs and teachers' knowledge effect teachers' decisions in making choices for classroom instruction. A study by Fennema, Peterson, Carpenter and Lubinski (1990) shows that success in mathematics for males is attributed to ability whereas success for females is attributed to effort. Beliefs about the importance of mathematics to the future of students effects the planning and implementation of instruction. Internal beliefs of both the student and the teacher play an important role in learning mathematics. Fennema (1990) contends that equity does not exist in the classroom. By the end of high school, males have learned more and different mathematics than females.

Goals of the Project

The Women in Mathematics Project for the year 2000 was developed using the goals of the NCTM Curriculum and Evaluation Standards (1988) and the research literature on gender issues in mathematics. One of the main goals of the project was to give teachers a knowledge base in gender issues in mathematics and in problem solving. The knowledge and experience gained in the workshop prepared teachers to become change agents when they returned in the fall to their schools.

For teachers to become change agents when they returned to their local schools, three key components of the project were focused on in the workshop:

- Providing an opportunity for teachers to develop a knowledge of variables that influence teacher decision-making processes which affect classroom instruction, students' cognition, and learning in mathematics
- Providing an opportunity for teachers to incorporate cooperative learning, manipulatives, and technology in developing a challenging and positive learning environment to promote higher-order thinking skills

- Providing an opportunity for teachers to apply the concepts discussed in the workshop immediately by working daily with groups of female students from grades 4 through 8 and then allowing for discussion and evaluation after each session.

The medium used to achieve the above goals was the Lego Logo program. This program provides a learning environment involving problem solving and technology to develop higher order thinking skills. Learning situated in a design context exploits cooperative teaching techniques, which females find preferable to competitive situations (Leder, 1992). Lego Logo is a construction set which includes motors and light and touch sensors. The Lego Logo program uses a version of the programming language Logo. Lego Logo lends itself to mathematical and scientific activities that promote problem solving and higher-order thinking skills. This creates an environment for learning that allows students to become inventors, and promotes the ability to create and explore concepts. Students "do" mathematics and science and relate concepts to the real world. Self confidence is increased by being able to explore, design, and redesign projects, usually exceeding the original expectations of the students.

Project Design

Fifteen elementary school teachers, grades 4-8, attended a three-week workshop in the Summer of 1994. This workshop was partially funded the past two summers under a Dwight D. Eisenhower Mathematics and Science Education Program Grant. The teachers, fourteen females and one male, were selected from a pool of applicants. An effort was made to select pairs of teachers from a single school so that they would have peer support when they returned to their schools in the fall. The project personnel included two college teachers and one middle-school teacher each having expertise in one or more of the following areas: mathematics, mathematics education, technology and gender issues.

The first week of the project the teachers spent experiencing the Lego Logo program, becoming aware of gender issues in mathematics , and discussing the role of problem solving in teaching in their classrooms, as well as the new role of the teacher as envisioned in the NCTM Standards. Literature on gender issues in mathematics and the NCTM Curriculum and Evaluation Standards (1988) was read and discussed. After developing this common knowledge base, teachers spent part of their time familiarizing themselves with the Lego Logo program by constructing projects, programming them, and then preparing lessons for the female students who would be joining the workshop during the second and third weeks. Concluding each day's session, a substantial portion of time was spent in group discussions in which teachers shared their experiences in teaching mathematics and shared comments on gender issues that arose in their schools and classrooms. In these discussions, teachers were able to develop an awareness of how the literature relates to their particular teaching situation and teaching situations of other participants in the project.

During the second and third weeks of the project, fifty-six female students in grades 4 through 8 joined the project.

During these two weeks, each teacher worked with a group of 3 or 4 students. In their first week, the female students constructed projects using designs that were provided with the Lego Logo program. These projects included cars, stop lights, washing machines, merry-go-rounds, conveyer belts, elevators, fans, a dinosaur, greenhouses, and a revolving disco stage. Students developed simple and then more complex programs to make these constructions move and perform a variety of tasks.

Constructions were built according to instructions and later, modified and redesigned to alter or expand their capabilities. Many design projects replicated real life and engineering problems such as: developing a wash-and-dry cycle for linens, jeans and delicate fabrics; developing a city street plan for stop lights that function similarly to the local stop lights; and developing a program for a robot-like turtle to run through an obstacle course.

The following week the female students designed, constructed and programmed original projects. Some of these projects included a portable fold-up phone that rang, a conveyor belt that played music and rejected every fifth item for inspection, a home with a door that could be operated by a touch sensor so that it was handicapped accessible, and a merry-go-round that played different tunes at different speeds. The final day of the workshop was a family day "open house" where parents were invited to visit and experience the projects that their daughters had designed, built, and programmed.

Teacher Reactions

A survey was passed out to all participating teachers on the first day of class. Only 10% of the teachers were aware of the NCTM Standards and only 30% stated that they were aware of gender issues in the classroom. After the workshop, a summative evaluation survey was answered by the teachers involved in the project. Teachers rated the workshop in six areas using a Likert Scale from 1 (meaning not really) to 5 (meaning definitely yes) related to the goals of the project. Table 1 indicates the average of the responses for each item listed.

In addition to using the Likert scale to evaluate the project, teachers were asked open-ended questions that related to each of the key components of the workshop and their plans for being change agents in their local schools.

Table 1.

Questions from Survey:	Average of responses
1. I will be able to and be interested in incorporating more ideas from the NCTM Standards in my teaching because of my experience in this workshop.	4.9
2. This workshop has allowed me to see how teacher questioning can promote higher order thinking	4.7
3. I feel more comfortable using computers as a result of taking this workshop	4.8
4. This workshop is a good example of how computers can be used in cooperative groupings.	4.7
5. Because of this workshop, I am more aware of gender issues that affect females in mathematica.	4.8

The following comments were taken from teacher responsesto the question: "What impact has the workshop had on your attitude and conceptual understanding of gender issues in mathematics?"

> *I was (but wasn't) aware of the statistics.*
>
> *This is a far greater problem than I had been aware of. I didn't realize the ramifications all the way through college profs., etc. It is a serious problem we need to address. I got some very great ideas on how to do that.*
>
> *I had not really thought about it. I'm not aware that I teach in a sexually-biased manner. It will be interesting to watch myself during the year and see if I still feel the same.*
>
> *I was not aware that I may be guilty of gender bias. I've seen that we need to involve girls more in problem solving in order to encourage more higher-order thinking.*
>
> *I had no idea there were such huge gender issues. Now that I am aware of them, I intend to be part of a move to rid teaching of mathematics of our society's gender issues.*
>
> *I knew there were some gender issues but this opened my eyes even more.*
>
> *It made me aware of things I didn't realize I was doing.*

Seventy percent of the teachers in the workshop listed gender issues as one focus for their teaching in the fall when responding to the statement: "List 2 or 3 areas where you will focus your attention in your classroom as a result of this course." Comments from teachers included the following:

> *As a result of this course, I will focus my attention on gender issues and questioning techniques.*
>
> *I will be more aware of gender bias when it does occur. I hope I am not labeled a feminist when I point it out.*
>
> *I will use cooperative learning involving the girls more.*
>
> *Gender issues—not just in math, but a new perspective on how I deal with quiet girls versus loud boys and the message I"m sending them.*
>
> *Gender issues—look at materials with the idea that they might be sexually biased and then supplement as needed.*
>
> *I would like to do a gender-issues talk at our fall in-service and make the staff aware of problems and relatively simple classroom remedies—awareness is a crucial factor to change.*
>
> *Cooperative learning, problem solving, questioning, and think-time with gender bias in mind. Encouraging the females and allowing them to feel capable.*

Discussion

Based on the surveys and comments from the teachers, the participants in the workshop became more aware of and more concerned about gender issues in mathematics. From observations of discussions held during the project, some teachers believed that gender biases do not exist in today's classroom. As one teacher in our workshop stated: "That was true twenty years ago, but not today." This led to a lively discussion led by teacher participants in the workshop, reaffirming that based on their personal experiences, sex biases are still frequently present in educational practices. From the teacher comments, most participants in the workshop showed a clear interest and intent in returning to their classrooms with a increased awareness of variables in the classroom that affect learning of mathematics for females. They developed many ideas for positive changes to make in their individual classrooms and schools.

In planning for the first year that this workshop was funded, the project personnel did not adequately gauge the amount of computer anxiety present among the teacher population being targeted. Modifications were made in the design of the project to allow for greater flexibility to meet the needs of individual teachers, and to place teacher comfort level as a high priority in their learning environment. As one teacher wrote:

> *First of all, your course title of "Increasing the Role of Mathematics for Women" kept me from seeing the word PROGRAMMING!! Had I known that we were to learn programming, I would have never signed up for the course because I've always believed that I wasn't capable of programming!! (I now know that I am—and it is no longer an anxiety issue for me.) My new attitude is if I can do it, anyone can do it!! For that I thank you.*

In this project the teachers participated in a new role-that of a facilitator of learning rather than a dispenser of knowledge. In this role teachers became learners along with their female students. This new role for the teacher is one that the NCTM Curriculum and Evaluation Standards (1988) envision for all teachers in the 21st century. By using cooperative learning groupings and questioning techniques that promote higher order thinking , teachers as well as their students approached problem solving from a new perspective. When using "how" and "why" questioning techniques with students, teachers were able to evaluate alternative teaching techniques in a cooperative classroom environment. They were enthusiastic about seeing the level of thinking that this type of questioning elicited in the students. As one teacher commented:

> *It was a great asset to be able to try new methods for teaching instantly, rather than waiting for several months for the fall semester to begin. Many times you forget what you have learned by fall and are no longer as enthusiastic about trying out new ideas.*

Our project continues throughout the year. We currently have a Mathematics Club which consists of the female students from our two summer projects and teacher participants who choose to join the group. We also have kept in contact with the participating teachers from our project and have been available for support with materials or items for discussion. Parents and school administrators have been very supportive of the project. Three area schools have allocated in-service time for teacher-participants from our workshop to share ideas from the project with their school colleagues. Two schools have given teachers financial support to get materials related to the project. Several PTA organizations, private businesses, and parents have supported the teachers from the project in getting supplies.

This is the second year our project was funded by the Dwight D. Eisenhower Education Program. It has been rewarding to see the positive change in attitude of the teachers, parents and female students involved with the project. From conversations with area teachers and administrators, it appears that many of the teachers in our project have become positive change agents in their local schools. The effect they have will move their students and schools closer to achieving the vision of Goals 2000 and NCTM Curriculum Standards (1988).

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Observation and Analysis of Mathematics Students Using Computer Technology

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> Perhaps the most evaded of all topics in schools is the issue of gender... As girls mature they confront a culture that both idealizes and exploits the sexuality of young women while assigning them roles that are clearly less valued than male roles. If we do not begin to discuss more openly the ways in which ascribed power—whether on the basis of race, sex, class; sexual orientation, or religions—affects individual lives, we cannot truly prepare our students for responsible citizenship (American Association of University Women, 1992, p.3).

Why Study Gender Differences

Since the emergence of the United States, Americans have witnessed phenomenal changes. From 1776 to the present, America has undergone an evolution from an agrarian society to an industrialized society and on to an industrialized nation. These dramatic shifts and other manifestations of social reality can be defined and explained by key concepts, such as race, class, gender, age, and culture (Altbach & Lomotey, 1991). Specifically, in our society these dramatic shifts have been the impetus for numerous changes in education (Kern, 1989). For instance, the role of science and technology in American society is currently undergoing dramatic change. According to a report published by the National Science Foundation (1994), American society is becoming increasingly technology-oriented. Thus, a basic understanding of science and mathematics is essential for those who pursue careers in scientific and technical fields and, for all people. This understanding can minimize a "... population that is ill-prepared to fulfill the needs of a technically competent work force or to exercise their full rights and responsibilities of citizenship in a modern democracy" (National Science Foundation, 1994, p.1). Therefore, if our nation is to remain economically viable during the next decade and beyond, it is imperative that we begin to examine those key concepts, specifically gender equity, that have traditionally endured educational, political, and economic neglect. Studying patterns of gender differences in educational achievement can help to determine whether or not patterns of career achievement are equitable between females and males (Linn, 1992).

Gender Education Achievement Gaps

Research discloses that our educational system is not meeting the needs of females. For instance, females and males enter the educational arena roughly equal in measured ability. However, twelve years later, females have fallen behind their male counterparts in key areas such as higher-level mathematics and measures of self-esteem (American Association of University Women Report, 1992). There is widespread agreement among researchers that we must respond to this challenge, examining gender achievement, in order to ensure that every individual has a full range of opportunities for personal fulfillment and participation in educational institutions and in our society. A crucial step toward correcting the educational inequities is to identify and examine them publicly and to develop reform agendas that promote educational equity in order to close the gender achievement gap (Sadker, Sadker & Steindam, 1989). This research examines differences between preservice teachers toward the integration of computer technology in their respective school sites and use with their course work.

Research indicates that females use computers while males love them (Markoff, 1989). The objectives of this study were to examine preservice teachers' attitudes toward the use of autonomous learning through the use of heuristic incorporation of learning resources (manipulatives) other than the teacher. Secondly, students participated in the structuring of lessons which transitioned from teacher directed to a decentralized situation. Students, as well as the teacher, supplied information through the use of the computer and the Internet.

The preliminary results of this study showed that female preservice teachers interacted more when permitted to assist in the structuring of the lessons; incorporated learning resources (manipulatives and computer) at their respective schools more than male preservice teachers. In addition, females used some type of manipulative with all lesson plans, while the males used the traditional lecture method.

Students were required to submit assignments through e-mail and encouraged to join Internet organizations, i.e., PRESTO, and to correspond with each other, the teacher, and other users of the Internet. This study revealed that 40 percent of the males met minimum requirements (course work) but did not correspond through e-mail; and 60 percent of the males completed assignments and corresponded frequently using the Internet. The study also showed that only 12 percent of the females met minimum requirements (course work) and correspondence. In addition, the research revealed that 88 percent of the females completed assignments and maintained frequent correspondence.

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SOCIAL STUDIES

This section includes three papers that demonstrate innovative ideas regarding the integration of technology in social studies. Social studies has suffered from a over-reliance on traditional methods with research indicating that students view social studies curriculum and instruction as irrelevant. The ideas presented in these papers suggest that technology has an exciting role to play in the teaching of social studies - facilitating meaningful learning of social studies knowledge, skills, and attitudes. The indication is that technology must be a major component of pre-service social studies teacher education if there is to be successful integration at the pre-college level.

The first paper, by Richard A. Diem, discusses the "mental communications revolution" caused by technological innovations. Dr. Diem provides practical and innovative strategies in approaching the issue of the role of technology in society through integration in civic education. The author discusses both curriculum and instruction issues regarding new technologies. He ends by indicating the possibilities technology may bring to education and society and stongly hints of the need to increase awareness of technology as a tool.

The second paper, by Steven Marx, discusses the possibilities of appying telecommunications in social studies teacher education and pre-college teaching. The author discusses telecommunication resources available and methods for applying the resources in social studies education. He also suggests strategies for teaching the skills necessary to facilitate the integration of telecomunications into social studies. The author includes suggestions for both pre-service and in-service social studies teachers.

The paper by Steven H. White, discusses the role of multimedia for preservice teachers in elementary social studies. The author suggests that technology such as multimedia applications can address student needs and assist in making social studies more exciting. The paper discusses multimedia project development in preservice methods courses and evaluation of the projects at elementary sites. Findings indicate that multimedia may assist with social studies learning.

The final paper, by John Parmley and colleagues, describes an interesting collaboration between a college of education, a national park, and a museum association. The result is a series of technology-supported social studies experiences that will be of interst to many social studies teacher educators.

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Technology and Civic Education: New Directions - New Issues

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The United States is in the midst of a revolution as powerful as any movement in human history. This revolution, which could best be called the "mental communications revolution", is being brought about by rapid changes in information/communication technology. As the industrial revolution extended the physical energy and power of each person, this revolution is extending the mental energy and power of human kind in ways as yet unknown. One of the first products of this upheaval has been the introduction of microtechnology to our nation's school systems.

Teachers have long made use of the technology they have had at hand. Traditional forms - such as textbooks, chalkboards, opaque projectors, records, radio, and film - have long been staples in the classroom and as part of teacher preparation programs. Recently, overhead projectors, photocopiers, television and video tape have taken their place as part of a téachers's technology inventory. During the past fifteen years the marriage of microtechnology, specifically microcomputer technology, with education has created both hope and dismay among those who looked to this form of technology as a means to improve the ways in which we school ourselves. As an off-shoot of these promises hundreds of thousands of microcomputers, cd rom units, laser disc players, and various software packages have been sold to homes as well as to schools as a means to better our educational systems.

Despite the widespread introduction of micro-technic hardware and concurrent software in schools, there is still a lack of understanding of the impact on the educational and social implications of these machines in terms of their effects on civic education. As a result efforts to integrate technology as part of overall social studies and civic education instructional processes have been largely unsuccessful.

In analyzing this problem, several reasons for this issue are readily apparent. First, and perhaps foremost, is the lack of coherent training and application programs for the vast majority of preservice social studies/civic teachers. In the latest National Council for the Social Studies report on NCATE accredation one of the top five reasons not meeting NCATE/NCSS social studies standards related to not having a technology course that included content application.

Those whose lives have been changed with the advent of micro-technology, particularly teachers and teacher educators, need to understand how to use and apply technology as well as how the tools of technology have changed the basic fabric of educational delivery and social systems. This raises the second reason for failure - the lack of integrating social studies concepts while using technology. Thisä is of particular import to teacher educators charged with preparing social studies instructors. For within this curricular area one a major focus revolves around discussion of societal change concepts as well as cause and effect relationships. In the wake of technological advancements and change, their impact on schools and society must be examined.

To introduce these ideas to preservice students, and encourage their practice as these new instructors take their place in the nation's schools, new paradigms of organizing material and ideas for instruction mustä be part of any teacher preparation program. This would involve understanding that teaching, particularly when it involves the use of technology allows for a broadening of the traditional student-teacher relationship. In the traditional model, information flow was controlled and maintained by the teacher, or instructor. Information flow was usually in one direction - from the teacher to the student. When the instructor wished, such as in a discussion, or independent study mode, the student was allowed to intercede and alter this model. With the advent of technology that not only calls for, but encourages individual student interaction with content material different types of instructional sequences appear.

In these, the student, with some teacher control depending on the software and hardware in use, now takes control of the flow of information. In the classic civic technology simulation on predicting presidential and voting patterns, now available on interactive cd-rom, the student, not the teacher gathers data, analyze it, and predicts outcomes, all without an instructors's interdiction. Even traditional evaluation models based on simple recognition and recall have been challenged as students can prepare a portfolio based on their interpretation of a given problem.

In addition to changing the nature of instruction in preparing teachers for civics classroom, there also needs to be a shift in curricular emphasis that includes an examination of some of the issues that arise from the use of technology. This include the social dilemmas that arise from the use of technology, both in society and the schools that include issues of the right to privacy, as well as the economic dislocations that technology may cause. Preservice social studies education students need to learn how to develop a perspective of technological developments and their effects on society - past present, and future as wellä as national and global. This can be done by studying about technology - its nature, role, and effects. Through this students can understand the nature of change and the benefits and costs to society as a whole. Students need to consider the nature of technology, what it is and how it has evolved.

Ways to incorporate these concepts within a teacher peparation course include the use of case studies to examine, within a historical perspective, the collection of the large mass of personal data collected about individuals in our society, the economic value that information now commands in the market place, and the potential that exists for abuse of that information. Citizen's rights of access to information gathered about them, and the ethical implications and standards related to data gathering could also be part of a series of lessons that incorporated technological pedagogy within this type of content.

Another area of emphasis that should be introduced as part of a civics/social studies teacher preparation program is how technology has altered our lifestyles. For example students might be asked to develop a unit that looks at how changes in communication devices, cellular phones and fax machines for instance, has altered the way and where business is now conducted. How has this technology changed our private lives as well as our public one's? Does the government have a right to control the use of this technology in public places, such as schools? A unit of this type would present participants with scenarios in which decisions focusing on applications of technology in home and classroom appear.

All teachers, at the pre and inservice levels need to keep informed of all new types of technologies so that they can deal effectively with the changes that they will introduce in society as well as within educational formats. Technology has the possibility of revolutionizing instruction both in elementary and secondary schools. But teaching is only—a tool—and thus we all need to help educators with the struggle that Thoreau described as the industrial revolution swept over the United States namely: We must learn how to behave so that we will not be the tools of our own tools.

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Toss the Text: Integrating Telecommunications in Social Studies Teacher Education

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This paper examines the uses of telecommunications in the social studies and ways of training preservice and inservice social studies teachers to successfully wield those tools. This investigation takes three main avenues: telecommunications resources available to social studies inservice and preservice teachers; methods of using those resources in social studies classrooms; and the best ways of teaching the skills needed to integrate telecommunications in the social studies classroom. Innovative ideas in telecommunications education will be examined, both classroom examples and new ideas.

Some of the author's current and recent experience with preservice undergraduate teachers will be discussed, including student reactions to telecommunications and final student projects using telecommunications. The students are taking the required undergraduate Educational Technology class at New Mexico State University in the fall 1994 and spring 1995 semesters.

Telecommunications Resources

Telecommunications today may well provide more useful and innovative resources to secondary social studies teachers than computer software. Much of this comes in the form of reference material available online. These include the *CIA World Factbook*, an annual reference of over 200 countries with their economic, political, and demographic information, US government resources, and current news. Some of the collections available on line include pictures and primary source documents. The Library of Congress has several of its recent exhibits available with excellent text and graphics, including: formerly secret documents from the Soviet archives; a Dead Sea Scrolls exhibit, and a Columbus exhibit. These databases are "virtual" versions of actual exhibits, made available for all who have telecommunications access.

Another type of reference material is research people are doing which they post for others to read and use for education. Sometimes these also include digitized pictures taken by the researcher. Some examples with pictures I found while browsing were research on Roman ruins in Turkey and various collections of art, some university collections, some collections organized by researchers.

The most popular telecommunications resource is e–mail, e–mail pen pals is especially popular in K-12 schools. There are a variety of ways of getting your students pen pals from virtually anywhere in the world. This has the benefit over traditional pen pals of supporting almost instant communication. And real time conversation is possible between students with a little planning.

The above is a brief look at some of the commonly used resources available on the Internet. Many more exist, and can be found by active searching or browsing. The next section discusses some ways of using this information in the social studies classroom.

Telecommunications Methods

It may seem too soon to talk about traditional versus non–traditional uses of telecommunications in the classroom, but there are some methods and ideas that have become somewhat typical. Thus this section is divided into two parts, one on the more traditional uses of telecommunications in social studies, one on more advanced and innovative ideas.

Traditional

As mentioned above, e-mail pen pals are probably the most common use of telecommunications in the social studies, or any other class. Students can get pen pals from states, countries, or areas they are currently studying and exchange ideas and facts. Having students get answers from their peers on questions of history, government, environment, and others issues provides a valuable alternate source of information. The information students get from other students can be compared to the information students get from other resources, possibly raising questions of historical accuracy and bias and the value of alternate views. For these reasons, e–mail will probably continue to be a popular telecommunications tool, especially in the social studies and language arts classrooms.

As might be expected, the Internet is also popular for doing online research, and it can make a school's library holdings almost irrelevant. Information on almost any subject can be searched for by keyword, and valuable sources of information are available in any social studies field. As mentioned above, the *CIA World Factbook*, encyclopedias, news, and current research are all available for free reading and downloading.

Connected with the subject of information retrieval and research, the bulletin boards (BBSs) and Usenet groups on the Internet provide another huge resource for teachers and students. There are boards and/or groups on almost any subject. All someone has to do is post a message on a question they have and all the other members will read it and respond if they can help. Nobody knows the people asking questions are high school, or even sometimes elementary, students, especially if teachers check messages for grammar and content before posting. Thus students can get feedback and help on projects from experts in the field, again available free of charge.

These methods are valuable now, and our schools - especially our social studies classes - would definitely be better off with universal access. As will be discussed in the final section, using these methods is also relatively easy and requires little training. They are also easy to integrate into an existing curriculum, although that would certainly not be the preferred method. The following examples and ideas provide a glimpse of the future of telecommunications and the way it can reshape the social studies classroom.

New & Innovative

Some of the new ideas presented below are innovative twists on methods mentioned above, while some involve new ways of looking at telecommunications and the social studies curriculum. Not all of the activities below actually occurred in a social studies classroom; they all could fit easily in a social studies curriculum, however, and the teachers involved actually said they hoped for such cross–curricular work in the future (Avots, 1994; Coady, 1994). This seems to be more evidence of the typical slow pace of social studies teachers in taking up new technologies.

The first two innovations regard new ways of using e–mail. One comes from Virginia, and involves students in e–mail communication with "Thomas Jefferson" (Willett-Smith, 1993). The e-mail messages made an historical figure come to life for the students, who asked him questions on his time period and important events as well as outside issues, such as having to explain the sport of basketball to someone who had never heard of the game. Some of the students' reactions to the experience show high levels of thinking as well as an enthusiasm for history often missing in today's classrooms.

Another expanded use of e–mail, also mentioned above, is having real–time conversations among students. Students can be given responsibility for planning, scheduling, and creating the rules for conversation, such as how to signal you're done typing a message, who should start, and other logistical issues. This can be combined with pen pals, as a major project done once or twice a semester. This could also be used as a highlight of long–term class projects, as detailed below.

Another innovative use of technology combines telecommunications with multimedia authoring, and turns students into creators, not just consumers, of content (Avots, 1994). This project had students in a foreign language class researching country information using *MacGLOBE* and several online resources, including the *CIA World Factbook* and French Minitel. They used this information to create presentations to the "UN" for aid. The class voted on three countries to get aid after the presentations. Then student groups used this information and HyperCard to create interactive "tours" of their countries. This project integrated telecommunications with multimedia and authoring in project–centered but content–intensive work.

Other students are creating sites on the Internet's World Wide Web (WWW) (Harris, 1994). Using an easy programming language called HyperText Markup Language (HTML) students are creating home pages on Mosaic than anyone around the world can visit and look at. Student's final projects are included as well as links to other relevant WWW sites.

An online World Politics simulation would be another innovative way of using telecommunications tools. Teachers could sign their classes up to be countries. With a few beginning hints on where to look, and using any software they already have, students would have to research their country's economic, political, and demographic information. Then, after using other sites to research current events in their countries, they would have to create a foreign policy, including goals and objectives for the simulation.

Students would communicate with each other, attempting to accomplish their goals, using e–mail and possibly occasional real–time chat sessions. They would communicate whenever possible, and set up the running of their country however they thought best. Ultimately some sort of real summit would be held, bringing students together in person who had been communicating all semester or year.

Space constraints preclude more details on this subject here. For more information, send e-mail to the address at the end of the paper.

The above ideas represent some of the newer and older ways telecommunications can be effectively used in the social studies classrooms. The next section describes the types and methods of training necessary for social studies teachers to use telecommunications effectively.

Teaching Telecommunications

As with all other attempts at integrating new ideas in the classroom, the key to success lies in training the teachers, both preservice and inservice. Studies show that more than gender or even anxiety, training, experience, opportunity, and school support determine whether and how well teachers use computers (Wiburg, 1994; Becker, 1994; Snelbecker, Bhote-Eduljee, & Aiken, 1992; Okinaka, 1992; Kinzie & Delcourt, 1991). Fortunately, most of the current popular telecommunications tools do not require a high level of training to use, and can be easily taught in separate workshops.

Colleges of Education

With the current spotty inclusion of technology in teacher education, teaching preservice and upper level students telecommunications can be tricky. Fortunately e-mail is becoming a common method of communication, especially among college students, many of whom have free Internet access. Many of my students wrote in their final papers that after they got their e–mail accounts they discovered friends and relatives who also had accounts, and now they preferred communicating with e–mail.

Telecommunications needs to be a part of any educational technology course, the trick is getting those courses to become common features in all Colleges of Education. E-mail is a good, simple way to start. I have students get accounts during the first or second class. The basic commands are simple, and more details can be introduced as students become more comfortable. E–mail comprises approximately 10 percent of my students' grades, and many engage in conversation outside of assignments. While this involves more work for me, it adds a more personal method of communication with students, and a forum where they can express their concerns in private.

Additional steps could include having students send e-mail to addresses of their interest. Addresses for locations in all disciplines could be provided. In the social studies, this could include the president and vice president (president@whitehouse.gov and vice.president@whitehouse.gov), Congresspeople who are online, as well as other government agencies. This would help students start to realize some of the potential telecommunications holds for their classrooms.

If available, students should also be introduced to both *Turbogopher* and *Mosaic*. If those aren't available, you can use regular gopher as a relatively easy method of browsing or searching the Internet. One popular method of introducing students to Internet resources and how to get around is an Internet treasure hunt or another type of searching game (Barron, Ivers, & Sherry, 1994); again this could be individualized to the different disciplines including social studies. Lesson planning using these resources and projects integrating and/or demonstrating information students find should be among the telecommunications assignments.

Because I focus on project–oriented assignments, most of my suggestions are geared in that direction. For final projects involving telecommunications, possibilities include: unit plans integrating telecommunications, with a demonstration of a lesson plan for the unit; sample unit/lesson plans integrating telecommunications with interactive multimedia; extensive subject–area investigation of available resources on the Internet, including descriptions of available information, addresses, and reviews; writing HTML pages, including links to other WWW sites; and anything else students come up with.

Final projects of my students from the Fall 1994 semester included: an HTML page written for Mosaic; a pen pal lesson plan, including sample questions in a variety of categories; additions to the chapter on telecommunications in the student–written textbook; and a sample lesson plan for elementary students, finding recipes on the Internet using Turbogopher and using them in class. An extension of the final idea would be to have students looking for recipes from certain parts of the world or for certain holidays.

Aside from e–mail, in my classes I did little more than briefly demonstrate Turbogopher and Mosaic and hand out instructions for using both. Students used one or both and e–mailed me about what they found. Many had trouble getting into Mosaic. In fact in some classes I couldn't get in to demonstrate it. For this reason and a lack of enough time in class to get experience with both, most students preferred Turbogopher, finding it easier and faster to use. The few students who got into Mosaic and had a chance to look around preferred its graphical, hypertext interface.

In the future, based largely on student response, I will include more telecommunications earlier and have more assignments relating to it. In terms of preliminary instruction, all that is needed are written instructions, with screen pictures at appropriate points, plus brief whole class demonstrations of the programs. Then students need to have plenty of time in class to experiment, again possibly using Internet treasure hunts, or looking for information in certain subject areas. Lack of time with telecommunications was the biggest complaint of my students regarding using online resources.

Furthermore, educational technology and telecommunications must be integrated into the methods courses, allowing students to focus in on their subject area in some depth. Obviously for this to happen, the methods professors need to be familiar with technology, potentially a problem for social studies. For this reason, faculty workshops should be offered on a variety of subjects by educational technology faculty.

Inservice Instruction

Inservice instruction and workshops are a way of providing needed instruction to inservice teachers. These workshops must have a very specific focus and, as in everything else mentioned in this paper, be extremely hands–on. Full or half day workshops could cover getting accounts and using e–mail, Wide Area Information Servers (WAIS) and gopher, WWW and Mosaic, and file transfer and retrieval (ftp). Specific workshops for social studies could focus on lists of resources available at different places, information retrieval, social studies lesson planning using telecommunications, and social studies and technology forums and newsgroups.

Training needs to be focussed on the needs of the teachers who will be using the technology, not what administrators, technology coordinators, or anyone else may want. Teachers should be asked ahead of time what type of training they want and in what areas. A simple questionnaire would be adequate for this. For those unfamiliar with technology, possible examples could be given. Too many inservices try to either cover too much information too broadly, or cover too narrow a subject in too much depth.

As with all other technology integration into the schools, training of inservice teachers needs to be an integral part of adding telecommunications to the classroom. If teachers don't understand or feel comfortable with the equipment and the technology, the will not use it. Making training available and useful to those who want it must be the focus of these programs.

Conclusions and Recommendations

Telecommunications will play a central role in our lives and the lives of today's students. E–mail, bulletin boards, file transfer, and online research are becoming common tools in the universities and some elementary and secondary schools. This diffusion will continue into homes, as modems become as common as personal computers in homes, and as access becomes easier and cheaper. The teachers of today and tomorrow have the responsibility of making sure their students understand and are able to use these tools.

Unfortunately, in social studies education today the computer all to often is a foreign intruder. Telecommunications has the potential of avoiding some of the pitfalls involved in using technology in the social studies classroom. Teachers don't have to learn lots of new software, they can start with the basics; teachers also don't have to have detailed knowledge of the Internet, just the skills necessary to get online and start searching. Their students will be able to advance this knowledge, and hopefully begin teaching the teachers if necessary. The teachers need to have the confidence to begin this process, and training is the key ingredient.

For social studies teachers, the Internet provides a wealth of free resources and interesting possibilities. No longer will teachers have to worry that their maps are out of date, or the information in the textbook comes from 1984. Up–to–date information on almost any subject is available 24 hours a day, for them or their students to locate and download. Furthermore, the bulletin boards and Usenet groups provide a host of forums for teachers to swap ideas, activities, and problems, and get professional support, again 24 hours a day.

For social studies teachers not to take advantage of the possibilities would be a crime against their students. It is incumbent upon the teacher educators of today to make sure all their students are ready, willing, and determined to integrate technology and telecommunications in their classrooms. Social studies teachers might need specialized or individualized activities within the educational technology classes. But technology and telecommunications must be integrated into the social studies methods classes. This is the only way preservice social studies teachers will get the depth of knowledge and practical experience they need.

Opportunities should be provided for preservice teachers to use telecommunications with students. This could be done in two ways. Students could go into classes that implement telecommunications – integrated lesson plans, or classes could be brought into university computing labs, if available, for instruction. Either way, this type of activity would serve as inservice instruction for the teacher as well, showing them how to do something and the benefits to be derived. This would also help create ties between the university and the community.

For inservice social studies teachers, general technology and telecommunications workshops need to be combined with social studies-specific training. Once social studies teachers see the possibilities and what's available, they'll want the training. And once they get the training they need, they can revolutionize social studies teaching and education, creating intrest and enthusiasm in social studies not accustomed to enthusiastic students.

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Preservice Teachers Develop Multimedia Social Studies Presentations for Elementary Grades

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As education moves toward a more technological age, teachers will need to apply their thinking to new, emerging, and integrative uses of technology within the content areas, and to innovative approaches for addressing student needs. In social studies, the role of technology can lead to more active learning and adventurous teaching. By integrating technology techniques into courses, social studies can become more exciting and forward-looking and possibly meet the needs of students with different learning styles. The key is to plan strategies when it is appropriate to the needs of the social studies student. For social studies educators, the challenge is how to use emerging technology effectively and creatively within our curriculum goals.

Studies suggest that the use of technology can enhance student learning. A University of Michigan study reported that children can gain the equivalent of three months of instruction per school year when computers are available to them (Elmer-Dewitt, 1991). Twenty years of research show that computer-assisted learning produces at least 30 percent more learning in 40 percent less time, and at 30 percent lower cost (Perelman, 1987). When a computer is used for interactive multimedia methods of instruction, retention is raised to 80 percent, as opposed to 40 percent for discussion methods, or 20 percent for a lecture approach using visual aids (Northup, Barth, and Kranze, 1991).

With an effective series of technology-based curriculum modules and appropriate implementation strategies, social studies educators can realize positive results in learning. Not only can we read about places, we can take our students there with a click of a mouse. We can now see and hear people, we can compare locations, and we can provide visual aids to support concepts that may have been difficult to comprehend by only reading the text. With the wealth of information and the integration of that information with social studies content, technology is providing a way to maximize our ability to provide quick feedback and self-pacing, develop linear and non-linear thinking abilities, individualize instruction, and develop problem-solving and decision making skills (Michaelis, 1992).

Multimedia Development

Fourteen preservice teachers enrolled in a social studies methods course at a Texas university and ten preservice teachers enrolled in a social studies methods class at a Kansas university developed multimedia presentations as an optional assignment for the course. Presentations were developed using *Hyperstudio* software. Each preservice teacher had a choice of content: historical figures, geographic concepts, or information about specific sights and facts about the states. Topics selected included Abraham Lincoln, Frederick Douglass, Jane Long, Daniel Webster, Henry Cisneros, The Westward Movement, and Texas. Projects were to become part of a curriculum unit developed during the student teaching experience.

Preservice teachers attended four sessions on the use of Hyperstudio software. Each session lasted two hours and was conduced one day a week for four weeks. The first hour was a presentation on how to use the software and the second hour gave the preservice teachers time to apply what had been presented. Students were encouraged to work cooperatively, relying on peers for information about software tools and procedures, and through trial and error techniques. These sessions were conduced in a computer laboratory with Macintosh computers, Apple scanners, and various presentation equipment, such as monitors, liquid crystal displays (LCD), color printers, video recorders, and laser disk players. The first session demonstrated how to open the program, develop a hyperstack, move from card to card with the use of a button, add color and text. Students also began to gather information on their topic and develop their stacks. No limit was placed on the number of cards required for the presentation. The second session presented information on how to add scrolling to text so that the students would not be limited to the amount of space provided by each card. Additionally, students learned how to place buttons behind unfamiliar text to help with vocabulary, and how to add audio to the cards in the stacks. The third session demonstrated how to scan and save pictures in PICT files, file, place pictures on cards in the stacks, and how to arrange pictures and text on cards for presentation. The last session demonstrated how to present the *Hyperstudio* stacks on a liquid crystal display panel or with video monitors. The class also discussed how selection of color for background and text can enhance or hinder the ability of the student to read the text. The preservice teachers were given opportunities to work in the computer lab and develop their projects. The preservice teachers spent a minimum of ten hours on the projects. All preservice teachers completed their projects within a five-week time period.

Method

To evaluate the effectiveness of their projects and to answer the question - is there a difference in knowledge gain as related to how information is presented - a small research investigation was planned. Three preservice teachers agreed to use their presentations in the study. The multimedia presentations were taken to an elementary school which was equipped with a computer lab that contained Macintosh computers. Three intermediate classes consisting of mixed-age groups of fourth, fifth and sixth grade students were each divided into three groups. A total of thirty-eight students participated. Each of the nine groups spent time interacting with one of the multimedia presentations. Since the presentations were no more than five cards long, it was decided that a group of students would spend ten minutes with each presentation in either the multimedia computer presentation, a paper copy of the presentation, or an auditory version given by the classroom teacher. While group A was involved with the computer, group B would read the information from a paper copy by themselves, and group C would have the information read to them from the paper copy by the teacher of their classroom. For the second multimedia presentation, group A would read the information from a paper copy by themselves, group B would have the information read to them from a paper copy by the classroom teacher and group C would interact with the computer presentation. The third presentation had group A being read the information from the paper copy by the teacher, group B interacted with the computer presentation and group C read the information from a paper copy by themselves. The three presentations consisted of material on Frederick Douglass, Harriet Tubman, and Elizabeth Blackwell. To determine if there was any advantage to using the multimedia presentation over traditional forms of instruction (reading and being reaused, a pretest - posttest format was given. The assessment was presented to the students as, "Tell me what you know about Frederick Douglass (Harriet Tubman, Elizabeth Blackwell)." Classroom students wrote any information on a piece of notebook paper. A score was calculated for each student by counting the number of correct facts the student could provide on each of the three historical people.

Results

An analysis of covariance (ANCOVA) was used to asses any difference between the three modes of presentation. The pretest was used as the covariate measure with the posttest score used as the dependent measure in the analysis of differences between presentation modes. The use of the analysis-of-covariance design was to control statistically any initial differences in the students which might have been present and which might confound differences between the groups of students. Table 1 shows the means and standard deviations for each presentation mode for each historical person. The pretest was a significant covariate for each of the three presentations (i.e., Douglass, Tubman, and Blackwell), $F\,(1,3)=5.49, p<..02$, $\underline{MS}e=10.38$, $F\,(1,3)=8.25$, $p<.00$, $\underline{MS}e=19.61$, and $F\,(1,3)=9.76$, $p<.004$, $\underline{MS}e=4.90$ respectively.

Table 1
Means for Posttest Scores by Presentation Mode

Presentation	Presentation Self Read	Modes Teacher Read	Computer
Frederick Douglass	3.92 (n=13)	6.17 (n=12)	4.38 (n=12)
Harriet Tubman	5.69 (n=13)	4.21 (n=14)	8.09 (n=11)
Elizabeth Blackwell	2.92 (n=12)	2.25 (n=12)	3.00 (n=14)

On the basis of the ANCOVA, it was determined that there was not a significant difference between the modes of presentation, whether the student read the material by themselves, had the material read by the teacher, or whether they viewed the multimedia presentation on the computer. The presentation on Frederick Douglass, $F=(1,2)=1.25$, $p>.29$, $\underline{MS}e=10.38$; Harriet Tubman, $F\,(1,2)=.66$, $p>.51$, MSe=19.61; and Elizabeth Blackwell, $F(1,2) = .68$, $p > .51$, MSe=4.94 produced no significant F values. Since a significant F was not obtained, it can be concluded that the subjects participating in the investigation were able to recall similar amounts of information regardless of the way the information was presented.

Discussion

Although no significant difference was found between the three modes of presentation (self read, read to, and multimedia), two of the means for the multimedia presentations were greater, though not significantly. This should encourage the development and use of multimedia presentations in the social studies content areas. Perhaps the more interactive multimedia presentations become, the greater the amount of information retained by the student. With the exception of the Frederick Douglass material, the modes where the students interacted with the material, those which read the material themselves and those where the student proceeded through the multimedia presentation by themselves, produced the greatest amount of factual knowledge recall. Due to the small sample involved in this investigation, it is impossible to draw any kind of generalization, however, this investigation does point to topics that could be the subject of further research.

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Using Technology and Cultural Heritage to Provide Interpretive Learning Services

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A shared interest in using technology to enhance learning experiences is the central focus of a partnership which involves Kansas State University, Mesa Verde National Park, the Mesa Verde Museum Association, and a private sector technology organization known as The Avalon Group. Kansas State and Mesa Verde National Park recognize education as major elements in their individual missions. In addition, the Museum Association and The Avalon Group function as independent educational organizations and collaborating partners. With a common interest in finding and/or developing technological applications to advance their educational missions, the four organizations joined forces. The partners have targeted a wide variety of groups; including school age youth, Park visitors, and other individuals or groups who may or may not be able to visit Mesa Verde. The partnership was initiated three years ago and has explored a variety of educational concepts, including the school-based concept they call *interpretive learning experience.*

Educational Role of the National Park Service

On August 26, 1916, President Woodrow Wilson signed legislation that established the National Park Service for the purpose of giving unified administration to parks and monuments under the jurisdiction of the Department of the Interior. The Service maintains each site, protects the natural and cultural resources and conducts a range of visitor services; including interpretation of the geology, history, and plant and animal life of the parks. Providing interpretations is the central focus of the Service's educational mission.

Concern for the rapidity of change and a variety of challenges facing the National Park Service led to a major planning conference held in October, 1991. During the conference, participants identified six strategic objectives. Among these strategic objectives were education and interpretation. The conference participants had the following comments about the current state of the interpretive and educational mission of the Park Service: "As education resources, the National Park Service is a premier national education system. ... Much of the interpretive activity in the NPS (National Park Service) is imaginatively conceived and well-appreciated by visitors" (National Park Service, 1992, p. 88). At the same time, the participants recognized additional opportunities and challenges by stating that "appropriate technologies are often under used" (p. 88).

Formation of the Partnership

Based upon this Park Service perspective and a long standing commitment to interpretation and education, the Mesa Verde staff entered into a partnership with the Kansas State University College of Education in an effort to explore opportunities for using technology to enhance visitor experiences and learning experiences of school age youth. Subsequently, the Mesa Verde Museum Association and the Avalon Group were invited to join the partnership.

The K-12 classroom concept - Interpretive Learning Experiences

In classroom settings, the partners believe the experiences of prehistoric Native Americans can be used to enhance student learning in a wide variety of academic subjects such as: Geography, History, Science, Math, Language Arts, Humanities, and other related disciplines. The classroom concept is designed around what the authors are calling interpretive learning experiences. While the authors' current efforts are directed toward the KSU-Mesa Verde project, they believe interpretive learning experiences have application far beyond this initial endeavor.

This concept, as applied to the Mesa Verde Project, provides an opportunity for learners to investigate one or more of the major questions which remain largely unanswered following the departure of the prehistoric civilization from the Mesa Verde region in the latter part of the thirteenth century. Three of these central questions include: How were these people able to make the move from a nomadic existence to a more permanent civilization? What was life like for these people during their stay in the region? Why did nearly 40,000 people leave the Mesa Verde region during an estimated 24 year period after having lived in the region for approximately 800 years?

The instructional concept provides an opportunity for students to consider a question such as, "What was life like at various time periods in the development of the Ancestral Puebloan culture?" Students then obtain an overview of the culture and the present setting by (a) interacting with a CD product being developed by the partners, (b) viewing digital graphic images, (c) reviewing traditional printed information, (d) examining information obtained through electronic interaction with the Mesa Verde staff and other possible information sources. Next, students begin to investigate a number of more specific questions through further interaction with identified data sources. For example, middle level or junior high students utilize their math and science skills to analyze primitive crop production, soil conservation practices in shallow soil, and the impact on settlements located at 7,000 feet elevation on a fragile ecosystem. Students use their knowledge of social studies to analyze population densities, reasons why groups or clans occupied certain locations, and reasons why the current population in the region was approximately 20,000 as compared to approximately 35,000 - 40,00 individuals who occupied the region at the height of this prehistoric culture. After analyzing such questions, students synthesize information and draw conclusions. Next, they develop a technology-based multimedia interpretation of their finding and conclusions. Finally, students present their interpretation to their classmates and respond to questions which help them evaluate their own work as well as the efforts of others. This learning concept, along with the cultural content of the project, has been field-tested in classrooms in Kansas and Colorado and seem to be appropriate for locations across the country.

Through interaction with other educators, Park Service staff members, and reflection on the results of field tests; the authors believe the K-12 teaching profession and the Teacher Education profession have much to learn from organizations such as the National Park Service. Specifically, the authors suggest we consider the National Park Service and its individual units, such as Mesa Verde National Park, as active members of the education family. Park Service professionals serve their clientele by making the learning and/or recreational experience as enlightening and enjoyable as possible. One of their secrets to success is their ability to help the visitor understand and appreciate the resource base over which they have responsibility. This assistance —enhancing the breadth and depth of understanding— is referred to as *interpretation*; a concept that should be examined by both K-12 educators and those preparing K-12 educators.

Why Interpretive Learning Experiences?

John Veverka (1994) defines interpretations as "a communication process designed to reveal meanings and relationships ..." (p. 19). In other words, interpretation is a process of sharing more than just surface information. Interpretation involves the sharing of insight that might come from "walking a mile in my moccasins," i.e., knowledge for, feeling for, and genuine insight into a concept, an event, a culture, or location.

Again, we need to reflect upon the value of such experiences for K-12 students. The Excellence Movement/School Reform Movement of the past ten years has consistently encouraged the education profession to develop and use strategies which enhance students' problem solving and critical thinking skills. But, what do we mean by problem solving, critical thinking, or higher order thinking skills?

If we consider the work of Bloom (1964) and focus our attention on what he termed the cognitive learning domain, we find that his taxonomy includes six levels listed from simplest to most complex, i.e., knowledge, comprehension, application, analysis, synthesis, and evaluation.

- *Knowledge* - A student who is proficient at the knowledge level of Bloom's taxonomy would exhibit such learning outcomes as: defining, describing, identifying, labeling, listing, matching, naming, outlining, reproducing, selecting, and stating.
- *Comprehension* - A student who is proficient at the comprehension level of Bloom's taxonomy would exhibit such learning outcomes as: converting, defending, distinguishing, estimating, explaining, giving examples, predicting, rewriting, and summarizing.
- *Application* - A student who is proficient at the application level of Bloom's taxonomy would exhibit such learning outcomes as: changing, computing, demonstrating, discovering, manipulating, modifying, operating, predicting, relating, solving, and using.
- *Analysis* - A student who is proficient at the analysis level of Bloom's taxonomy would exhibit such learning outcomes as: diagramming, differentiating, discriminating, distinguishing, identifying, illustrating, inferring, selecting, and separating.

- *Synthesis* - A student who is proficient at the synthesis level of Bloom's taxonomy would exhibit such learning outcomes as: categorizing, combining, compiling, composing, creating, designing, modifying, organizing, revising, and summarizing.
- *Evaluation* - A student who is proficient at the evaluation level of Bloom's taxonomy would exhibit such learning outcomes as: appraising, comparing, concluding, contrasting, criticizing, describing, discriminating, explaining, justifying, interpreting, and supporting.

If we conclude that these experiences are valuable and important for students, how have we been providing such opportunities? As we think about the typical K-12 interpretive opportunities, we might include the following activities and experiences:

- Having children tell stories or describe experiences
- Involving student of any or all ages in constructing art projects
- Involving students in musical experiences - instrumental or vocal (individual or group)
- Developing other visual art experiences - photography, sculpture, drawing and painting
- Authoring works of creative writing
- Involving students in speech and drama activities
- Involving students in food preparation and clothing construction activities
- Involving students in cultural experiences related to second language acquisition

While we are aware of traditional interpretive experiences which have been provided by schools, the authors contend that the addition of merging technologies provides significantly enhanced opportunities for such experiences for students in all disciplines, and therefore; advances the development of critical thinking and problem solving skills of all students.

Thus, if we can develop strategies which help students function at the higher levels of Bloom's taxonomy, we will help students to be more effective problem solvers. In addition, they will become more effective in analyzing often conflicting information, synthesizing such information into meaningful "packages," and evaluating their own work as well as the work of others.

But, how do interpretive experiences help advance an agenda of problem solving, critical thinking, and higher order thinking skills? The authors suggest that interpretation within the context of the model provided by the National Park Service gives a framework for developing learning activities and experiences. Consider the student or team of students who are confronted with the challenge of investigating the following question: How did the ancestral Puebloan people whose culture is preserved within Mesa Verde National Park come to the Southwest and, specifically, to the Mesa Verde region?

To address this question, students would need to obtain information or data from a variety of sources and in a variety of formats, i.e., printed information, perhaps personal observations, verbal or electronic interviews, and available audiovisual information. It seems reasonable to think that these students would also need to comprehend the data they received; which might also involve the need for determining its application. Next, the students would need to analyze the sources of information into a meaningful and manageable "package." In addition, they may also have significant amounts of conflicting data. This data would then be synthesized into what they believe to be meaningful accounts from which they would draw conclusions. If at this point students had access to a variety of computer-based resources, i.e., textual, visual (still or motion), auditory (sounds or music), and an authoring system which supported the use of various media; the students could develop a multifaceted interpretation of their understanding of the question. This interpretation could include multi-sensory representations of their understanding of the data related to the question and the conclusions which they have drawn. Finally, these students could share their multifaceted, multisensory, or multimedia interpretation with classmates and others. Thus, they would have an appropriate platform from which to evaluate their own work as well as respond to questions and evaluation from others.

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READING/LANGUAGE ARTS

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The thirteen articles in this section cover an interesting range of topics relating to reading, language arts and technology. One theme of a number of articles is the use of technology to help in teaching English to speakers of other languages. Henrichsen and Murray describe an interesting project aimed at providing distant learners with a range of "low" to "high" technology options for training as English as a Second Language (ESL) teachers. Padron and Waxman review the literature on the benefits of technology use with English language learners (ELLs, learners whose primary language is not English). They find some specific benefits supporting technology use with ELLs. Butler-Pascoe offers the results of a national survey on the integration of technology into Teaching English to Speakers of Other Languages (TESOL) master's degree programs. She finds that 58% of the programs surveyed indicate some progress in integrating technology into their courses and cites, among other data, specific software and its frequency of use in the programs represented by the respondents. Anderson writes about the use of the Internet by graduate students in a Foreign Language and TESOL program. His account demonstrates the type of changes (infusion of technology into TESOL programs) surveyed in the Butler-Pascoe article and offers information about how his students used the Internet.

Another theme was providing preservice and inservice teachers with models of technology use through integration of technology into their methods and content courses. Williams and Matthew used HyperCard stacks to present information about the writing process to preservice teachers and found that modeling the use of technology with preservice elementary teachers was a positive experience for the teachers and increased their knowledge of the development of writing. Wetzel and McLean integrated technology with an Early Childhood Language Arts course for preservice teachers. Their students participated in a holistic, constructivist learning model as they used *Kid Pix* to create an illustrated children's story. Allen describes e-mail and distance learning communications between eighth graders and preservice secondary teachers in a reading methods class. The preservice teachers observed reading, writing, and communications skills of middle school students and most reported positive benefits from the experience. Zbikowski and Pan describe a model in which teachers dealt with issues related to implementing technology, including multimedia, into the teaching of the writing process through a focus on development of their own writing skills. Staudt presents an experience of integrating technology into a children's literature course for preservice teachers and offers both a rationale for doing so and examples of assignments for the course. Rautenhaus offers a perspective, from Germany, on using e-mail texts in foreign language teaching. The author provides an overview, and a number of examples, of future teachers' work in adapting for classroom use stories collected via e-mail from pupils in various countries.

Other themes addressed include Wheatley and Greer's presentation of relevant background on the use of two-way interactive distance learning. They go on to describe their experiences and strategies in teaching a graduate reading course using this technology. Land and Taylor discuss the benefits of integrating technology into reading instruction to facilitate a constructivist approach. They offer a number of specific activities to help achieve this. Ford, Poe, and Cox studied use of CD-ROM for increasing automaticity and fluency in reading. They found use of CD-ROM storybooks to be a possible alternative to teacher presentation of a repeated reading technique. They also found that teacher training and experience with the software is very important.

These articles provide a rich tapestry of experiences and insights into the use of technology in the teaching of reading and language arts. We hope you enjoy them.

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A Distance Learning ESL Teacher Preparation Program Utilizing Both the "High and Low Roads" of Instructional Technology

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The availability of technology for educational applications increases daily. Yet there are frequent examples of how the technology used in the classroom is older, rather than newer, technology. One solution is to complain and wait for the users to catch up. Another option is to take on the role of change agent and promote the adoption of new technology. A third alternative, however, is to employ multiple media and give users an array of instructional technology options from which they can choose those which suit them best.

This gap between the availability and use of instructional technology has been observed by participants in Brigham Young University's Teaching English as a Second Language (TESL) Distance Learning Project, which is developing materials to prepare volunteer teachers of adult ESL courses. In our needs assessment during interviews and focus groups conducted with leaders of organizations that are existing or potential sponsors of ESL courses, and with the volunteer ESL teachers who will staff them, we have observed that their preferences for instructional media and learning environments are understandably diverse. These preferences can be placed on a continuum of instructional technology options ranging from the "low road" (print booklets) to the "high road" (video and computer-based lesson materials). We have also found that the selection and use of a particular learning medium by our audience is not based solely on the user's comfort level with technology or the instructional effectiveness of a particular medium. Additionally, their preferences are based on a number of other factors, such as affordability, available educational facilities, individual lifestyles, and time constraints.

This paper describes a distance learning program design which seeks to employ diverse types of instructional media to accommodate the individual needs and preferences of our audience. In sum, we believe that learners can reach instructional objectives by traveling either the high or the low road, whichever works best for them.

The Audience

Volunteer ESL teachers in community and church-based programs for adult immigrants and refugees to the United States constitute one of the largest groups of TESL practitioners in need of adequate teacher preparation (Halstead & Siker, 1994; Henrichsen, 1993). Nevertheless, these volunteers do not usually enroll in traditional, university-based, graduate-level ESL preparation programs. In fact, volunteer ESL teachers often are located at a great distance from the institutions that provide this type of training. Most of these prospective teachers do not have access to the range of emerging instructional technologies that are used on campus to support instruction. In addition, as part-time volunteers they often have other jobs, commitments, and responsibilities that are a higher priority in their lives than attending formal training courses. This reality presents a challenge to materials developers. Unlike on-campus certification programs for professional ESL practitioners in which teacher trainees may be required to take certain courses and use a prescribed instructional medium, volunteer teachers cannot be compelled to use training materials or media that are not useful or convenient to them. Our challenge, then, became one of creating a program that these volunteers could use on their own terms.

The Need

The needs of volunteer ESL teachers often parallel those of the ESL learners they will teach. They are faced with everyday priorities which constantly compete for their time, energy and commitment. The needs assessment data collected from focus groups and interviews in the field suggest that, in order to be effective for our intended audience, the teacher preparation materials we develop must:

- be based on sound instructional principles
- accommodate both high and low technology applications
- activate different learning modalities (e.g. visual, aural)
- be user controlled (convenience, time, pace)
- provide teacher-learner interaction at a distance
- motivate users

Technology: The High Road and the Low Road

We have adopted a flexible approach in which learners may avail themselves of higher forms of technology at times and lower ones at others, but on their terms. We support a materials development approach that combines sound learning principles, motivating lesson materials and flexibility, to foster learning through both lower and higher forms of technology. In other words, wherever our audience chooses to operate on the technology usage continuum, we plan to meet their instructional needs.

The needs assessment conducted as part of the BYU Distance Learning Project determined that there were very few members of our audience who did not own a VCR, a basic technological tool that is widely available for instructional applications. In fact, it was *the* instructional technology of choice among prospective volunteer ESL teachers.

Consequently, we chose to begin by designing a video tape series that presents a variety of teacher preparation topics ranging from effective lesson planning to setting up and running successful adult ESL courses. Through viewing situational dramatizations on video, followed by reflection and peer counseling users can develop a sound working knowledge of ESL teaching without ever being in the physical presence of a teacher educator. On the other hand, although nearly everyone possesses a VCR, there are often times when it is impossible or impractical for them to use the video medium. For this reason, a companion workbook, designed to be used in conjunction with or independently of the video tape, accompanies each lesson module. In either case, a toll-free telephone help line is also available to provide the program users additional professional support and interaction as needed.

Higher Tech Options

As a next option—to expand the range (high technology to low technology) of materials available—we are exploring instructional media that use more sophisticated technology, such as CD-ROM and interactive computer applications using hypermedia. This will allow us to reach the segment of our audience which has access to, and chooses to use, computers. Looking ahead and developing more advanced technology options serves a twofold purpose. First, a small percentage of our target audience currently possesses the technology to use materials in these formats, and many desire these tools now. Second, like the VCR, which not so many years ago was a relatively high and not so widespread form of technology, tools like CD-ROM and the Internet will likely be easily accessible to an increasing number of our audience in a few years. We will then be well positioned to serve the needs of the increasing number of users who will choose this form of technology.

Summary

Eventually, through a flexible, broad offering of instructional media, ranging from traditional print booklets to hypertext on the World Wide Web, we hope to provide volunteer ESL teachers with not only a distance learning, but also a true "convenience learning" option, in which the time, location and pace of their instruction are user-controlled and accessible to them on their terms. Our task is to develop materials using commonly available technologies, while also exploring higher technologies, so that in the future these options will converge with the readiness of a growing portion of our audience as they gain the ability and desire to use them. We concur with Fred D'Ignazio's view cited by Mageau (1994) that "Teachers should think of multimedia as the opportunity to chose one or more media that are cheap, available, and appropriate for a given learning activity."

Our needs assessment research has helped us recognize that both the "high road" and "low road" approaches to using instructional technology will meet our educational objectives. More importantly, we have learned that by allowing our learners a choice of paths, rather than insisting that they follow just one, we can be most effective in assisting them in ultimately reaching their educational destination. In sum, if "you take the high road, and I take the low road," we can both "get to Scotland."

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Technology's Role in Improving the Teaching and Learning of English Language Learners

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Addressing the problems of English language learners (ELLs) is one of our most important national educational issues. This paper examines the role of technology in improving the teaching and learning for ELLs by: (a) considering some of the problems associated with their academic underachievement, (b) providing evidence of how technology can improve their learning, and (c) explaining how technology can change the teacher's role during classroom instruction. The implications for teacher education programs are also discussed.

Learners whose primary language is not English have often been described as language minority students or limited-English proficient students. This description, however, often has derogatory meanings in that it infers that students are deficient in language rather than the fact that they are mastering another language (La Celle-Peterson & Rivera, 1994). Consequently, the term "English language learner" has recently been used to describe those students whose first language is not English and they are either: (a) beginning to learn English, or (b) have demonstrated some proficiency in English (La Celle-Peterson & Rivera, 1994). The construct of "English language learner" (ELLs) helps educators reframe the problem from one of "blaming" the learner because they have a language "deficiency," to a perspective that focuses on the specific educational needs of ELLs because they are learning another language.

Latinos, who constitute the largest group of ELLs, have the lowest levels of education and the highest dropout rate of any other ethnic group (Cardenas, 1990; Kaufman & Frase, 1990). In Texas, for example, student enrollment from 1982-1992 increased 18%, however, for the same time period the ELLs population increased 53% (Texas Education Agency, 1992). In addition, approximately 40% of Latino students are one grade or more below expected achievement levels by the eighth grade and only about 50% graduate "on time" (Garcia, 1994). Many of these students are considered at risk of failure and are likely not to reach their academic potential (Poirot & Canales, 1993-94). The increasing number of Latino ELLs, the high number of ELLs dropping out, and the lower achievement levels of Latino ELLs constitute a critical educational problem (Garcia, 1994). Some of the problems associated with this academic underachievement and educational failure are: (a) inadequate programs for ELLs (U.S. Dept. of Ed, 1992), (b) a shortage of adequately qualified teachers of ELLs (Darder, 1993; Garcia, 1994), (c) at-risk school environments (Boyd, 1991; Kagan, 1990; Newmann, 1989; Waxman, 1992), and (d) inappropriate classroom instruction (Padron & Knight, 1990; Padron & Waxman, 1993; So, 1987).

To address these critical problems, educators need to focus on new instructional approaches for improving the education of ELLs. One research-based approach that has been found to improve the teaching and learning of ELLs is the use of technology in the classroom. Technology has been found to enhance and supplement traditional classroom instruction as well as offer a new way of delivering instruction (NEA, 1989; Office of Technology Assessment, 1988; Olsen, 1990; Polin, 1991; Rockman, 1991). Some of the specific beneficial roles of technology include: (a) fostering students' problem solving and higher-level thinking (Dede, 1989; Held, Newsom, & Peiffer, 1991; Lieberman & Linn, 1991; Office of Technology Assessment, 1988; Olsen, 1990), (b) enhancing student-directed learning and autonomous learners (Bell & Elmquist, 1991; Held, et al., 1991; Hornbeck, 1991; Lieberman & Linn, 1991), (c) providing diversity in instructional methods (Polin, 1991) and (d) becoming an effective management tool for teachers and principals (Bell & Elmquist, 1991; Braun, 1990; Hornbeck, 1991; NEA, 1989; Office of Technology Assessment, 1988; Polin, 1991). More importantly, technology-enriched classrooms can change the current models of teaching and learning to emphasize more active student learning (Sheingold, 1990) and change the role of teachers from deliverers of knowledge to facilitators of learning (Wiburg, 1991a).

Research on Technology and Students At Risk

There is growing evidence that suggests that technology can significantly improve the education of students at risk of failure and Latino ELLs. Olsen (1990), for example, found that integrated learning systems significantly improved the academic achievement of minority students from several minority school districts across the country. This integrated learning system included (a) computerized, criterion-referenced tests that allowed for individualized assessment, (b) courseware providing interactive practice and feedback and covering basic skills, higher-order thinking, and problem solving, and (c) an instructional management system that allowed teachers to monitor and track students' progress.

In his report for the International Society for Technology in Education, Braun (1990) examined several projects across the country that found that technology-enriched schools had a beneficial effect on student learning. He found several examples of technology that improved at-risk students': (a) attendance, (b) achievement, and (c) behavior. He also found several schools and districts that decreased the dropout rate for students at risk. Although much of the evidence that Braun (1990) cites is based on expert judgments and anecdotal information, there appears to be strong consistency across these and other findings to support his conclusions. Descriptions of other technology projects such as Gross (1990), Kephart and Friedman (1991), and Wiburg (1991b) all involve students at risk and all support Braun's findings.

There have also been several studies and reviews that have found that technology has a positive impact on ELLs (Chavez, 1990; Dunkel, 1990; Merino, Legarreta, Coughran, & Hoskins, 1990; Torres-Guzman, 1990; Walker de Felix, Johnson, & Shick, 1990). In a study conducted by Chavez (1990), for example, first and second grade students were instructed to use the "Write to Read" (WTR) Program to develop English writing and reading skills. The results of this study indicated that the use of the WTR Program provided a risk-free environment for students. This type of environment made students feel comfortable about expressing their ideas. Also, the results indicated that students' story writing showed improvement in sentence structure and in breadth of the content. Furthermore, there is research evidence that indicates that multimedia use with ELLs can produce positive effects. Walker de Felix, Johnson, and Schick (1990), for example, developed two interactive videodisk lessons that were tested with fourth-grade English as a second language (ESL), inner-city students. Their findings provided evidence of the advantages of contextually-rich learning environments.

How Technology Impacts ELLs

There are several conceptual articles and research studies that have examined the specific ways technology impacts students at risk. Instructional technology has been found to be beneficial for students at risk of failure in the following ways: (a) it is motivational, (b) it is non-judgmental, (c) it can individualize learning and tailor the instructional sequence to meet students' needs and rate of learning, (d) it allows for more autonomy, (e) it can give prompt feedback, and (f) it provides the students with a sense of personal responsibility and control, (g) it can be less intimidating to students, (h) it gives the students a rich linguistic environment, (i) it diminishes the authoritarian role of the teacher, and (j) it decreases situations where students could be embarrassed in class for not knowing answers (Cantrell, 1993; Hornbeck, 1991; Mielke & Flores, 1992-1993, Poirot & Canales, 1993-94). In addition, there is some indication that Hispanic students are more kinesthetic learners and learn better through hands-on activities and in small group and individualized instruction (Poirot & Canales, 1993-94). Computers provide for students a hands-on opportunity to learn and the ability to have students work in small groups. Furthermore, some types of technology like multimedia are effective for students at risk because they help students connect images, sound, and symbols (Kozma & Croninger, 1992; Poirot & Canales, 1993-94). Multimedia can also connect students' learning in the classroom to real life situations and authentic learning situations (Means & Olson, 1994).

DeVillar and Faltis (1991) specifically discuss the effectiveness of technology for ELLs by describing how computer-integrated instruction facilitates social integration, communication, and cooperation for ELLs. All of these characteristics of technology are especially beneficial for ELLs because they are often disengaged from schools and they have generally experienced more failure than success in learning situations.

One of the most important outcomes of technology-enriched classrooms is that it can help reduce or eliminate the "pedagogy of poverty" that exists in classrooms with ELLs (DeVillar & Faltis, 1991). Haberman (1991) argues that the typical style of teaching that is prevalent in most urban schools constitutes a "pedagogy of poverty." He maintains that this teacher-directed, instructional style leads to student compliance and passive resentment as well as teacher burn-out. Furthermore, he criticizes this orientation because teachers are generally held accountable for "making" students learn, while students usually assume a passive role with low engagement in tasks or activities that are generally not authentic. Several recent studies have examined classroom instruction for students in urban schools and found that this "pedagogy of poverty" orientation exists in many classrooms where there are predominantly minority students (Padron & Waxman, 1993). Consequently, this instructional approach for students which is quite prevalent in urban schools as well as most other schools across the country, may be one of the most serious problems educators need to address.

The Teacher's Role in the Use of Technology with ELLs

In order to increase the potential of technology in schools, teachers need training in the use of technology (Mielke & Flores, 1992-1993). This is important since recent studies have found that the longer preservice and inservice teachers are exposed to computers and the greater variety of computers they have experience with, the more comfortable they feel in using computers (Padron, 1993; Liao, 1993). Teacher training institutions must help to change the role of teachers in technology-rich environments to that of facilitators (Willets, 1992). It has been suggested that teacher preparation programs need to include several aspects if technology is to be incorporated from elementary to high school classrooms. These aspects include: (a) addressing classroom management issues, (b) exposing prospective teachers to classrooms where a variety of technologies are being used, (c) demonstrating various types of software and instructional methods that can be utilized with a diverse student population, (d) modeling of teaching and learning strategies by university faculty using computer-related technologies, and (e) training teachers in the evaluation of software (Chisholm, 1993; Hunt, 1994). The evaluation of software must include more that just being able to determine whether a particular program is of high quality or whether it is easy to use. For teachers of ELLs, the evaluation of software must also include being able to determine whether the software is culturally appropriate and whether it can be utilized by students with various learning styles (Chisholm, 1993).

The availability of technology provides teachers with new ways of providing instruction and enhancing learning for ELLs. Teachers, for example, need to be taught how to use technology to teach culture, academic content, critical thinking skills, and to enhance students' language development (Soska, 1994). Students' language development, for example, can be enhanced by having students work in small groups while using technology (DeVillar, 1989). Another issue related to language development, is that teachers of ELLs need to make technology-based instruction available in two languages. In the past, technology in two languages has not been readily available. This situation, however, appears to be beginning to change (Mielke, & Flores, 1992-1993).

Discussion

The continued growth of student populations that are culturally and linguistically diverse makes it necessary for educators to identify instructional approaches that help these students become successful in schools. The growth of technology use in schools in the U.S. makes it necessary to prepare teachers who can address not only cultural and linguistic differences, but can also help ELLs become academically successful. There is evidence that the use of technology has positive benefits for students from culturally and linguistically different backgrounds. In addition, research has suggested that effective educational environments for ELLs may need to include the following elements: (a) instruction in the students' native language, (b) a student-centered curriculum, (c) small group instruction, and (d) teachers who can create new and positive instructional environments (Garcia, 1988; Moll, 1988). These can be integrated by using technology and therefore help improve the teaching and learning of ELLs. Nonetheless, it is important that research continues to examine the impact of various technologies on ELLs. Research, for example, also needs to consider individual differences in terms of the types of technologies that may be most appropriate for a student with a particular learning style. These and other issues still need to be explored so that we can further understand technology's role in improving the teaching and learning of English language learners

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A National Survey of the Integration of Technology into TESOL Master's Programs

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National and state task forces on education in the United States have reported the need for computer-based technology in today's linguistically and culturally diverse classrooms (National Task Force on Educational Technology, 1986). Colleges and universities, however, continue to produce teachers who do not have adequate skills in utilizing computers for instructional purposes (Dell & Disdier, 1994; Thomas, 1991; Turner, 1989; Woodrow, 1993). Moreover, while research reports positive results of technology-based instruction with minority language learners (Cohen & Riel, 1986; Hunt and Pritchard, 1993; Phinney, 1989; Piper, 1987), there is growing evidence that minority cultures have less access to technology-enriched instruction than their majority counterparts (Campbell, 1988; Hunt and Pritchard, 1993; Skeele, 1993).

In view of the inadequate training of teachers in instructional applications of computers and the limited access of minority language students to comuter-based teaching, efforts need to be made to integrate technology with methods of teaching English to second language learners. In order to learn more about the state of technology in master's programs which provide specialist training for teachers of multilingual classes, a national survey was conducted investigating the role of computer technology in Teaching English to Speakers of Other Languages (TESOL) master's programs.

Method

The administrators of 153 TESOL master's programs listed in the *Directory of Professional Preparation Programs in TESOL in the United States 1992-1994* (Kornblum & Garshick, 1992) were surveyed regarding the integration of computer-based instruction into the curricula of their programs. The respondents represented public and private institutions in 44 states, the District of Columbia, and Puerto Rico.

The questionnaire consisted of four sections exploring the extent and types of computer instruction employed. The first section asked whether a program's current curriculum offered any type of instruction in the use of computer-based technology and, if not, whether inclusion of such instruction was anticipated in the near future. Respondents who indicated current use of computers in their programs were instructed to complete the remaining sections of the questionnaire.

The second part of the questionnaire asked respondents to identify the types of courses offered: 1) a computer literacy course focusing on educational applications 2) a course in computer-assisted language teaching, 3) TESOL methods courses that provide hands-on practice integrating computers into the curriculum 4) courses that utilize computers for research, and/or 5) others. The third section investigated the use of various types of computer applications for teaching second language learners. The last section asked respondents to indicate which computer platforms (e.g., IBM-compatible, Macintosh, and/or Apple) their TESOL programs utilized for classroom instruction.

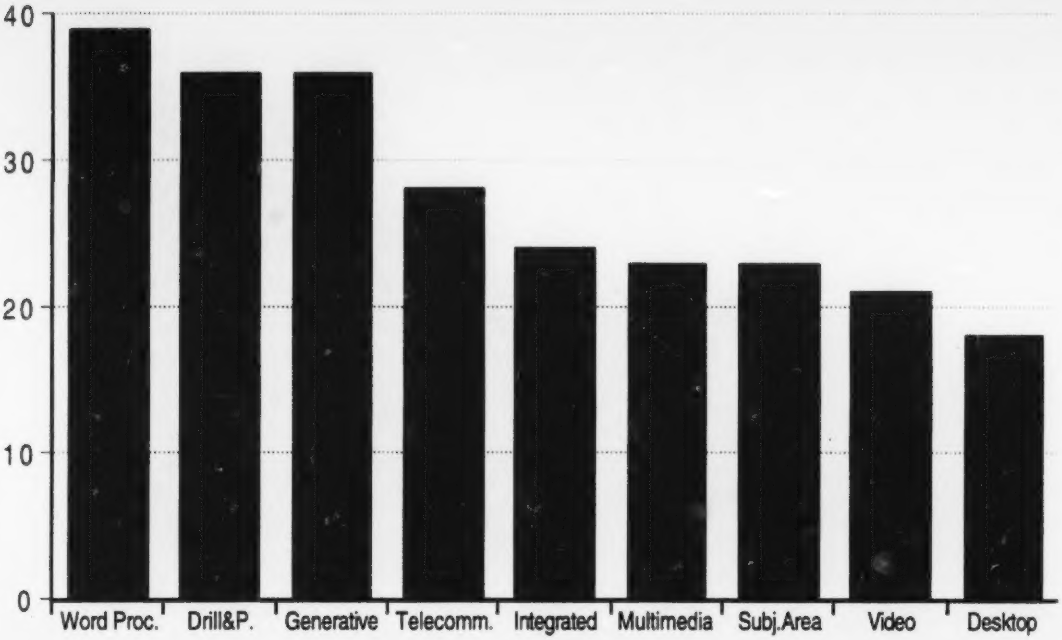

Figure 1. Software Applications Used in TESOL Master's Programs

Findings

Of the 153 TESOL administrators surveyed, 112 responded to the questionnaire. Of those, 63 reported that their TESOL programs included some form of instruction in computer-based technology while 46 indicated theirs did not. Three institutions no longer offered a TESOL master's program. Respondents from 14 of those programs not currently utilizing computer-based technology reported plans to do so in the near future.

When queried about the types of courses included in the TESOL master's curriculum, the 63 respondents from computer-using programs reported that 20 programs offered a microcomputer course focusing on classroom applications; 20 provided a course in computer-assisted language learning and teaching; 28 offered methods courses that provided hands-on experience in developing a computer-enriched curriculum; and 36 included courses that utilized computers for research purposes. Other courses which used computers included materials development courses in 3 programs, speech analysis courses in 2 programs, and a multimedia development course in 1 program. In lieu of course work with computers, 3 programs offered workshops in various computer applications for English language teaching.

As for study and hands-on instruction in using various computer applications, the greatest number of TESOL programs (39) reported using word processing, followed by drill and practice (36) and generative software (e.g., puzzle or story makers, problem-solving programs) for English language development (36). The next most frequent use of computers was for telecommunications, used by 28 programs. Twenty-four programs reported using integrated software; 23 indicated they employed multimedia; 23 used software that was appropriate for teaching subject-area material (sheltered instruction), and 21 demonstrated interactive video. Only 18 programs modeled desktop publishing. Figure 1 presents, in graphical format, the software application use data.

TESOL Programs

With some programs reporting use of more than one platform, Macintosh computers were used in 45 programs, IBM-compatibles in 38 programs, and Apple computers in 7 programs.

Conclusions

TESOL master's programs have begun to integrate computer technology into their curricula but have done so in limited numbers and scope. Over 41% of the TESOL programs responding to the survey did not utilize any type of computer technology. Only 25% of the programs offered methods courses that provided teachers with the skills needed to integrate computers into their classroom teaching. Unfortunately, the consequence of inadequate teacher training in the use of computers is obvious in our classrooms. Fewer than one-fourth of the teachers serving language minority students use computers in their teaching and insufficient training is cited as a primary reason for their failure to do so (Hunt and Pritchard, 1993).

There were, however, some encouraging findings regarding course offerings. Fifty-eight percent of the TESOL programs surveyed indicated some progress in infusing technology into their TESOL master's courses. A small but significant number of programs (18%) offered a course in computer-assisted language learning (CALL), and over 35% offered courses that utilized computers for research purposes.

In an investigation of the applications modeled in TESOL programs, the three most frequently cited—word processing, drill and practice software, and generative programs for English language development—require not only a proficiency with the software but also an understanding of the pedagogical issues involved in their use. The critical factor in the success of these software applications is the teacher's knowledge of how to best use them in the ESL curriculum. For example, the cognitive and affective benefits of word processing as part of the writing-as-a-process approach with second language learners are well documented (Engberg, 1986; Phinney, 1989; Piper, 1987). Drill and practice software programs for language development are most effective when applied to grammar structures within the context of students' writing (Wiburg, 1993). Appropriate use of student-centered generative software engages students in problem-solving tasks that enhance critical thinking while developing language skills. Teachers need extensive training and practice with these applications in order to develop classroom lessons that capitalize on the strengths of the computer as a medium of instruction.

The use of telecommunications reported by 26% of the respondents suggests a growing recognition of the potential of telecommunications in second language teaching. Electronic mail provides students with authentic audiences to read their developing writing. The TESL-L network allows ESL and EFL teachers and students to share their research and engage in collaborative projects with global perspectives.

Multimedia is a more recent application than word processing or drill and practice, but over 21% of the responding programs currently model its use. Nineteen percent of the TESOL programs provide instruction in using interactive video. The prominence of multimedia in TESOL programs is likely to increase as more TESOL professionals recognize the value of multiple modalities in providing comprehensible input for students with limited English proficiency and varied learning styles.

Over 21% of the TESOL programs reported providing instruction in the use of software that was appropriate for subject-area instruction for second language instruction. Many states now require pre-service and in-service training in delivering specially designed academic instruction (SDAI) to language minority students. Computers can clearly play a major role in allowing students to engage in academic tasks that focus more on their intellectual abilities than their language limitations.

Surprisingly, desktop publishing was the least demonstrated application despite its relative familiarity to teachers and its acknowledged motivating role in the process approach to teaching writing to second language students.

Overall, this survey reveals the limited progress, yet promising potential, of TESOL master's programs as resources for teacher preparation in the effective delivery of computer-enriched instruction to minority language learners.

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Using the Internet in Graduate Language Teacher Education

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Graduate teacher education increases students' subject area knowledge, introduces them to competing theories, trains them in research methods, equips them for a successful job search, and welcomes them as professional colleagues. When students enrolled in such a program are introduced to the Internet, "students" can quickly gain a sense of growing into "professionals". This is what happened at Fairleigh Dickinson University (FDU), New Jersey in the spring of 1994.

Fifty graduate students in the Foreign Language and TESOL teacher education program received an average of thirty minutes of instruction on how to use an Internet mail program, and they immediately put this new tool to creative uses. Students used the Internet to communicate with each other, correspond with relatives living outside the U.S., extend professional contacts beyond the university, search for jobs, and conduct research.

Getting Started on the Internet at FDU

As a new faculty member, I signed up for a computer account that gave access to the Internet. At first I used it to keep in touch with a few colleagues, but within a few weeks, I subscribed to the TESL-L (Teachers of English as a Second Language) listserver. About twenty-five messages a day came into my electronic mailbox, and I enjoyed reading the professional dialogue of others. The technology impressed me, so I told three students about TESL-L, e-mail, and the Internet. All three became interested in getting e-mail accounts, so the university created accounts for them.

Learning e-mail on your own is different from teaching it to students. I spent several hours deciphering the e-mail instructions from the university's computer services department and several more hours experimenting to discover what the e-mail program could and could not do. Though some of my students could successfully go through the same process, most would give up in frustration. To help students, I prepared a sheet of instructions to guide students step-by-step to turn on the computer, change their password, get into e-mail, get out of e-mail, and log off the computer. A separate sheet of instructions told how to subscribe to TESL-L, read mail, and delete mail. I sat with the first three students individually as they worked through the instructions, and they soon started receiving mail and sending messages to each other. Their excitement about the quality of discussion on TESL-L prompted me to teach e-mail to others.

To tell others about e-mail, I asked the first three students to share with their classmates what they saw as the most beneficial aspects of the TESL-L listserver and e-mail. After hearing the enthusiastic reports, several other students expressed interest in learning more. Enough interest was expressed that I offered a Technology in the ESL Classroom course in the three-week January intersession.

Sixteen students with little experience using computers enrolled in the technology course that also included an introduction to HyperCard and video. When we started e-mail, each student chose a partner and began to work through the instruction sheets. Instead of helping each other through the instructions, however, problems occurred in pairs, and I frantically went from pair to pair trying to discover what instruction was skipped or what key was hit inadvertently. Fortunately, one of my first three students was in the computer lab and had enough experience to help half of the students. In two to three hours everyone eventually became proficient in reading and sending mail though some occasionally needed help in later sessions.

Students quickly began going beyond subscribing to just the TESL-L listserver. Some students subscribed to foreign language education listservers, others to Asian news listservers, and others sent e-mail to friends and relatives around the world. The excitement about using the Internet increased proportionately to the number of students using it.

In the spring semester I incorporated e-mail into the curriculum of the required Second Language Acquisition course. Students had a choice of either attending a professional conference or completing a series of assignments using e-mail. Thirty more students wanted to discover what the Internet could do for them. I reproduced more instruction sheets and scheduled thirty-minute appointments to teach two students at a time to work through the instructions. I also posted a schedule of when I would be available in the computer lab to help students who still had difficulty. The quality of the TESL-L discussions was high enough that many students found that they learned as much from the discussions as they did at conferences. More than fifty of the ESL and Foreign Language master's degree students used e-mail regularly by the end of the semester.

Keeping up with the needs of students was a challenge, but not too difficult. The two instruction sheets were inadequate to teach everything, so I began to periodically send tips on how to get more out of the mail program. Tips included how to reply to a message, send mail to more than one address, and store messages in different folders and then find them again. I kept the tips in a folder so I could send them to students with new accounts and to those who inadvertently deleted earlier tips. I kept a directory of our little network of subscribers to post local job announcements, library resources, and upcoming conferences that might be of interest. These efforts accomplished more than just introducing students to a new technology—students also learned to use the Internet as a tool in their professional development.

What Students Did with the Internet

Master's degree students in education learn current theories and modern practices. The TESL-L listserver discussions go through cycles of discussing different theoretical approaches or classroom practices for teaching English. Some postings enthusiastically support a theory or practice, while other postings will bring up difficulties with the theory or practice. The topics covered are often those not mentioned in the classroom, which increases a student's subject area knowledge. Student subscribers overhear professional conversations in their area of interest every time they read their mail. After a while, students discover that they have learned enough in the classroom or as a teacher of language that they have something to contribute to the discussions.

Several students were aided with research projects by using the Internet. Whenever someone posts a request for information on a listserver like TESL-L or LINGUIST, several people reply with useful information. One of my students made an inquiry about teaching holidays and another student made an inquiry about a sociolinguistics problem. Both students received useful information and suggestions for bibliographic resources. Another student searched gopher resources for help. Though I did not specifically teach e-mail for research, several students discovered it on their own. I did, however, direct individual students to useful electronic archives. Because the university has a computer lab with more than one hundred stations connected to the Internet, students often met at the lab in the evenings and weekends. They often helped each other with research projects by keeping a watch out for messages that were relevant to the projects of their classmates.

Most of the students in the Fairleigh Dickinson master's program were looking for a full time job. Those willing to move out of the local area regularly read the postings from the TESLJB-L listserver, the jobs branch of TESL-L. Those looking for jobs closer to home anxiously waited for me to post the foreign language, bilingual education, and ESL jobs advertised in the local newspapers or in fliers from school districts. More importantly, students who spend several hours receiving and sending messages over the Internet gain a degree of expertise not shared by most job applicants. My students feel comfortable around words like information superhighway, cyberspace, and Internet. In letters of recommendation I mention that they can use this new technology, and I encourage them to bring up their experiences with e-mail in job interviews. When twenty applicants apply for a single job, the person who gets the job often has a skill that others lack. I tell my students to stress their unique skills when applying for a job, especially their knowledge of information technology.

With the variety of personal histories found in a master's degree program in education, students find a range of applications for this technology. The following section is a sample of some of the uses this particular mix of students made of the Internet.

Case Studies

Case 1: Les

Les was my first student to use e-mail. Whenever we saw each other, we usually shared what new feature or listserver we discovered during the week. Les was our local expert on gophers and FTP sites. We also talked often about topics currently being discussed on TESL-L. Les was looking for a teaching job overseas, so he subscribed to TESLJB-L, the jobs branch of TESL-L. He applied to several jobs that he first saw on the list, and by the time the TESOL (Teachers of English to Speakers of Other Languages) International Conference ended, Les had more than five offers. He had to decide between the Middle East, Europe, and Asia, so he turned to the TESLJB-L listserver and its subscribers to ask about different employers. He received dozens of responses and is now teaching English in

Korea.

Case 2: Christina

Christina was my second student to use e-mail. Wanting to teach full time at the community college level, she was intrigued by the possibility of having professional dialogue with others in the ESL field who shared experiences similar to hers. After finishing her master's degree, she continued to be active on the Internet and asked TESL-L subscribers the following:

Hi, fellow netters. I'm Christina and I'm a new user (and also a fairly new ESL teacher). I'm wondering if anyone knows of publishers of ESL games. It seems to me that the major ESL publishers, such as Prentice Hall and Oxford, publish only books and cassettes. Is this true, or do any of them also publish games that could be used in an ESL classroom? I'm mainly interested in games for the secondary level through adult. Any leads would be most appreciated, and I thank you in advance. (TESL-L. 31 March 1994)

I encouraged her to keep a record of the responses she received, and those responses are now in the archives of TESL-L. The file she initiated, organized, and sent to the archives will continue to be a resource for other TESOL professionals for many years.

Case 3: Bob

Bob was my third student to use e-mail. Several years ago he took a trip to Australia, and he has been looking for a way to go back to Australia ever since. Like Les, Bob subscribed to the TESLJB-L jobs list. He also watched for any postings from TESL-L subscribers in Australia. Whenever he saw a posting from Australia, he used the reply function of e-mail to introduce himself and to ask for leads regarding TESOL jobs in Australia. Soon Bob was corresponding on a regular basis with several linguists in Australia. At the TESOL International Convention he met and talked with many of the people with whom he had been corresponding. Though Bob still has not found a job in Australia, he has many friends there with whom he still corresponds.

Case 4: Judy

Judy is an adjunct professor in the English department at FDU who took my intersession course. She has a son who teaches English in the Czech Republic. The day after she started on the Internet, she called her son to get his e-mail address, and they began corresponding regularly over the Internet. Judy was going to the TESOL International Convention but she needed someone to share a hotel room. Since TESL-L provides a convention roommate service, Judy signed up for the free service and found a roommate.

Case 5: Jackie

Jackie was a student desperate to find a research topic. Since she was interested in phonology and dialects, I suggested that she might try to find the geographic distribution of an English dialect feature. In New Jersey the words "cot" and "caught" are pronounced differently, but in California they are pronounced exactly the same. "Don" and "Dawn" are also pronounced the same in California. To extend her research beyond the library and her acquaintances in New Jersey, I suggested that she ask for help from subscribers to TESL-L. We composed the following posting:

In our English Phonology class, we learned to recognize the vowels and diphthongs. Since all of my fellow students and I are from New Jersey, we had no problem recognizing cot-caught, don-dawn (or Don-Dawn) as two sets of minimal pairs in which the vowels contrast. Our professor, however, just came to New Jersey for the first time from California, and he couldn't make the distinction if his life depended on it. All English pronunciation textbooks teach the contrast, but who contrasts don-dawn, and who does not? Is the contrast disappearing? If you could, please respond to me, not to the list, answering these four questions:

1. *For you, are don-dawn, cot-caught the same or different?*
2. *Where were you born?*
3. *What region of the U.S. or other part of the English-speaking world most influenced your speech?*
4. *Would you like the results of my study?*

Thank you.

Jackie (TESL-L. 21 July 1994)

Within two weeks, we received more than 80 replies to the message. A few responses were of no use but most were valuable and a few gave humorous anecdotes of how Californians are sometimes misunderstood when they say "caught" or "Dawn". Jackie not only received good information for her project, but also an appreciation for the helpfulness of other TESL-L subscribers.

Case 6: Mei

Mei teaches English at the community college level in Taiwan. To ensure advancement in her job, she came to the United States to study for her master's degree. Unlike most of the international students in the program, she was already married when she started the one-year course, but her husband stayed in Taiwan to work. Highly motivated to get everything she could from her time in the U.S., she read every posting to TESL-L and wanted to learn everything she could about computers and the Internet. She also supplemented phone calls to Taiwan with messages over the Internet, which made her absence from family a little easier.

Case 7: Yin-Huei

Yin-Huei is also an English teacher from Taiwan. After taking the Technology in the ESL Classroom course, she wanted to learn as much as possible about computers and the Internet before she returned home. She decided to do a survey of computer resources for the ESL classroom for her mini-thesis. A good resource for Yin-Huei was the TESLCA-L branch of TESL-L, which discusses computer-assisted language learning issues.

Case 8: Larry

Larry likes to chat. Though most TESL-L subscribers are reluctant to expose their thoughts to the whole list, Larry thrives on it. He joins right into the TESL-L discussion, tells everyone how the New York Rangers are doing, and often quotes from Star Trek. The Internet and TESL-L are social outlets for Larry. He subscribes to other lists and bulletin boards, but he stays with TESL-L because teaching English is the profession he has chosen.

Case 9: Digna

Digna was one of my younger students who quickly became enthusiastic about the potential of the Internet. Whenever someone posted a question that she could respond to, she spent considerable effort to make a contribution. Digna attended professional conferences in New Jersey and New York announced on TESL-L. Reading postings about current issues on TESL-L helped her to select which conference sessions to attend, where she found that presenters were often people who posted to TESL-L. Digna also pursued employment in Spain over the Internet, but she is still waiting for a job offer.

Case 10: Sirimas

Sirimas teaches English in Thailand. Besides reading the postings on TESL-L, she subscribed to many listservers that gave news of Southeast Asia. This gave her a sense of not being so isolated from home. When a posting came over the Internet from Thailand requesting information about studying English in New Jersey, she responded, giving her perspective on the issue.

Student Response to Learning to Use the Internet

The case studies reflect my observations of how some students used the Internet. The basics of the original assignment were that students needed to spend a minimum of ten hours on the Internet and send me replies to eight queries.

For the last query I sent the following message:

QUERY #8 LAST ONE!

1. *Estimate the total hours you have spent on this assignment since the beginning of the semester (reading mail, driving out of your way, trying to get things to work, etc.).*
2. *How valuable have you found the TESL-L discussions to be?*
3. *How has e-mail helped your professional development or knowledge about new technology.*
4. *Any other comments?*

The responses varied from positive to negative and from articulate to inarticulate. I have chosen a representative sample of the more articulate responses that answer questions two and three. The following quotations are samples of student responses:

Reading the mail I have received over the weeks has been helpful in giving me ideas about what kinds of activities and techniques will work in my ESL classroom.

Since I have no experience with the new technology it has helped me immensely. It is a good introduction for me and it has piqued my interest in computers.

I found that many messages required more context than I have. There are too many inside jokes, arguments over speeches and articles unfamiliar to me, and answers to questions posed long ago. However, I gained insight into problems and controversies in teaching ESL and some good suggestions for classroom management and methods.

I am less afraid of computers than I was when we started this assignment.

The discussions about books, materials, games and techniques were very interesting. Many of them I have printed out to keep for my own reference.

They are great. I have learned what ESL people talk about on a professional level. I realize that I can understand what they talk about, even if I do not have anything unique to add to most conversation threads. I feel like I have become part of the ESL community by lurking, and by conducting my own private correspondence with folks on the list.

I was comforted to know that other ESL teachers have the same concerns, problems, etc. that I have encountered. I'm sure that many people who had something good to say didn't say it, and those who had nothing to say said too much, as is usually the case. Because I net from home I will continue to receive TESL-L. I may even send my own messages about games I use with my students, or inquire about other teaching strategies.

I don't feel as intimidated about computers as I once did. I didn't think I would have enjoyed the computer as much as I did.

I feel like I'm on the cutting edge and this puts me ahead in a job interview.

Other than making me an Internet addict, to replace my Big Mac addiction, but NOT my Chips Ahoy addiction, I have found the whole experience to be invaluable. I've learned a whole new way of communicating with the world—thankfully on someone else's dime! I cannot believe the worlds that have opened to me as a result. Now if the Australians would just take the bait, all would be perfect.

It is interesting to read what people around the world are interested in. Sometimes I get titles of interesting books, or conferences. The conference at BMCC was very interesting. I would not have attended if it wasn't for the e-mail.

It has made me more aware of technology and what's going on in this area. I want to keep up with this because I think that computers will be used in the ESL classroom more often in the future.

Most students were favorably impressed with the TESL-L discussions, but some found the discussions uninteresting and dominated by too few individuals. Responses from international students were not included in this sampling of quotations because the responses were very brief. International students found most TESL-L discussions to be a waste of their time because they could not see the relevance of the theories and practices to the teaching situations in their home countries. For these students, the value of learning e-mail and using the Internet was that they had learned a telecommunications skill that has potential value. At graduation, departing students thanked me most for introducing them to e-mail and the Internet because they know it is a tool they will use.

Discussion

Some students started on the Internet because it satisfied a course requirement, but most of them saw the value it would have for their professional development. None of the students had done any more than word processing with a computer before this time, but all increased their comfort with using computers after only a couple of hours on the Internet. A key to getting students started was that there were resources available on the Internet that matched the professional goals of the students.

After establishing an account, learning a few keystrokes and how to get out of the most common problems, students can begin receiving mail from a listserver. Beginners studying to be foreign language or ESL teachers at the undergraduate or master's level can subscribe to TESL-L, TESLK-12 (Teachers of English as a Second Language to K-12 students), or FLTEACH (Foreign Language Teaching Forum). Students with more advanced interests can also subscribe to SLART-L (Second Language Acquisition Research and Teaching), and LINGUIST. After reading postings to the lists for a while, students typically begin to respond to individual requests for information. Soon they begin to individualize their uses of the Internet to reflect their own needs and interests.

Necessary conditions for success in getting students to use the Internet at FDU were (1) easy access to computer terminals connected to the Internet, (2) an e-mail program at least as easy and as powerful as Elm, (3) Internet resources like TESL-L that are of genuine use to students, and (4) an individual (faculty, staff, or student) committed to getting new students started using e-mail even if they do not enroll in a technology course. Before I arrived at Fairleigh Dickinson, the first two conditions were satisfied but not the second two. When all four conditions were satisfied, we made rapid progress. I have been unable to duplicate this level of success at my present location because we cannot satisfy the first two conditions. Once we do, I am confident we will exceed our success at FDU because many new resources for language teachers are appearing on the Internet.

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The Implementation of Technology into a Language Arts Methods Course: User Response to Stages of Writing Development

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Research shows that integrating technology into preservice teacher education classes increases the probability that the students will use technology in their own classrooms (Gooler, 1989; Johnson and Harlow, 1993; Wright, 1993). Since teachers teach as they were taught, it has been further suggested that authentic modeling of technology coupled with hands on experience will motivate future teachers to use computers as an instructional tool. However, it is essential that preservice teachers know how to operate computers, as well as know how to effectively utilize them in their classrooms (Futrell, 1989). Therefore, providing students with authentic contexts for the application of technology in methods courses is a way of establishing instructional models, giving them additional exposure to using technology, and providing them with additional hands on experiences with technology.

Realizing the importance of this modeling of computer use in education methods courses and the importance of integrating existing course work into the technology, a set of HyperCard stacks, *The Stages of Writing Development*, was created for use within an elementary language arts methods course (Matthew and Williams, 1994). The purpose of these stacks is to present information about the process of writing and expose preservice teachers to authentic writing samples of young children. Specifically, the students had the opportunity to read about children's writing development and view samples of children's early writing, invented spelling, and composition, which represents a broad range of these developmental levels. Using existing curriculum from a corpus of language arts materials, accompanied by these actual examples of children's writing provides students with a rich context for learning. Consequently, the information presented in the stacks becomes more meaningful as students see the graphic displays representing text information.

Methodology

For the purposes of this study both quantitative and qualitative methods were used. In order to determine the effectiveness of the HyperCard stacks, *The Stages of Writing Development*, a survey approach was implemented. Additionally, participants were observed as they responded to the authentic children's writing samples.

Purpose

The purpose of this study was to determine the effectiveness of the integration of technology within an existing language arts methodology class for elementary education majors. Specifically, the study was conducted to ascertain a) the usefulness of the stacks in teaching about children's writing development, b) the ease of navigation and quality of organization of the stacks, and c) students' opinions.

Participants

The participants of the study were 40 undergraduate students enrolled in a large metropolitan university in the southern United States. Students volunteered to participate in the study and were compensated with additional class credit.

Materials

Materials for the study included the HyperCard stacks, *The Stages of Writing Development* and the survey, *User Response Guide to Stages of Writing Development*, created by the researchers.

The stacks consists of five linked stacks each with their own focus: 1) writing development, 2) early writing, 3) stages of invented spelling, 4) composition, and 5) response. The first stack, *Writing Development*, contains instructions, references, a main menu, and a structured overview of all the sections of each stack with links to the stacks. *Early Writing*, *Stages of Invented Spelling*, and *Composition* are composed of subsections that provide information about the writing process and are accompanied by authentic writing samples which illustrate the developmental stages of writing. At the conclusion of each section the user may choose to participate in a short multiple choice quiz. This serves as a metacognitive assessment of their comprehension of the material. At the end of the quiz students will receive a score; however, these scores are not recorded and simply serve to give the students an indication of how well they remembered the material. The fifth stack, *Response*, displays additional writing samples that the students are to examine and respond to based on the material they learned in the other stacks.

The survey included 40 questions designed by the researchers. Thirty of the questions required a Likert scale response and ten questions required open-ended or yes/no responses. Further, these questions focused on three areas: a) navigation, b) knowledge, and c) opinion. Navigation questions dealt with ease of movement through the stacks and organization of the material. Knowledge questions focused on the usefulness of the stacks as they pertained to acquiring new information about writing development. Opinion questions were developed to determine student's ideas and reactions to the incorporation of technology into the curriculum.Procedures

The participants met with the instructor for five weeks during a four hour block of time. One hour each week was spent in the computer lab working with the Stages of Writing Development. During the first week the students were given an introduction to the stacks and encouraged to explore them with a partner. The remaining weeks were devoted to individualized learning of the information in the stacks, analyzing additional writing samples, and typing their comments into the Response stack. While the students were engaged in the assignment, the researchers made observations, answered questions, and informally discussed stages of writing development with the students. At the end of the five weeks the students completed a survey about their experiences. The surveys and responses to the writing samples were analyzed.

Survey Results

The surveys were collected and the responses categorized according to a) navigation, b) knowledge, and c) opinion. Responses were tallied and percentages determined for each category. Next, the responses to the open-ended questions were analyzed for trends.

Navigation

Hypertext documents have to be carefully constructed so that users do not get lost while using them. Eight of the questions in the survey were designed to determine the ease with which the students were able to navigate through the stacks and the organization of the material. Overall, the majority of the participants responded favorably in this category. Specifically, the consistent placement of the buttons on the cards facilitated ease of use.

Knowledge

Thirteen of the questions were designed to provide information on how useful the stacks were for learning the course material. The majority of the respondents indicated that the placement of information and writing samples on the same page facilitated understanding of the material. The organization of the stacks and the structured overview enhanced their understanding of young children's spelling and writing development.

Opinion

Nine questions centered upon the students' opinions on the incorporation of technology into the curriculum. Here 71% of the participants responded positively to the usefulness of the stacks. Particularly, they enjoyed working at their own pace and typing in their own responses.

Open-Ended Questions

Responses to the open-ended questions indicated that participants enjoyed working in the computer lab. They reported that going to the computer lab offered an alternative to more traditional methods of teaching. In particular, they were receptive to gaining information via hypertext rather than the normal print medium. Specifically, they were highly receptive to the authentic writing samples, as they believed they became more aware of the range in children's writing development. Further, they stated that this knowledge would enable them to be more prescriptive as they planned writing lessons. Participants also reported that they were more comfortable with technology and believed that this would be a beneficial teaching attribute.

Responses

The range of responses to the writing samples varied from very detailed analysis to brief perfunctory answers. Additionally, the participants often suggested instructional strategies congruent with the philosophies of language arts acquired during their course work. Finally, the responses reflected only a snapshot view of the presumed stage of development. This was due to limited information about the child and the context of the writing sample.

Observations

While the students worked on the stacks, the researchers made informal observations. Although the participants appeared apprehensive during their first visits to the lab, they gradually became more comfortable within this setting. Students' previous encounters with computers affected their performance in the lab. For example, students who had computers at home and utilized them on a regular basis were far more comfortable with this assignment. However, those students who have had negative experiences or lacked basic computer skills, such as keyboarding, exhibited high levels of stress as they completed this assignment.

Discussion

The results of the survey indicate that the participants enjoyed their brief interaction with the HyperCard stacks and increased their knowledge of the development of writing. However, several limitations of this study must be considered. First, the number of participants was small, representing only a third of the undergraduate students enrolled in language arts classes. Next, the duration of the project was limited to five weeks to correspond to the length of the class. Different results may have occurred if the participants were allowed to have more access to the computer. Finally, not enough background information regarding the child and the writing sample was provided. This resulted in the participants making assumptions about the samples that were not always warranted. Despite these limitations, the overall results of the study are encouraging and suggest that undergraduate elementary education majors are receptive to the inclusion of computers into methods classes. Such inclusion provides students with opportunities to learn with computers and consequently models one way to teach with technology.

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Teaching Early Childhood Language Arts and Technology: A Creative Integration

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This paper reports on an innovative integration of two undergraduate courses at Arizona State University West: an early childhood language arts course and an educational technology course. Both professors believed that technology should be explained, modeled, and used within the context of methods courses, rather than as a stand alone course. Further, they wanted to teach their students, and thus encourage them to teach, in ways that reflected a holistic, learner-responsive curricular position in early childhood education. This included modeling a process approach to teaching writing, and demonstrated the use of technology as a tool for creative writing and early literacy learning.

The Early Childhood Curriculum Approach

The holistic early childhood curriculum is characterized by a dense network of fundamental interconnections both in terms of the teacher's planning and the children's experience. It is based on assumptions about the learners as whole children, rather than just the little slice of a child we might identify as 'student', takes all aspects of children's development into account, and tries to create environments in which children can learn using all of their senses. Furthermore, the holistic perspective is reflected in the consideration of content, where concepts are seen as having many layers of meaning that cross traditional subject area boundaries.

Inherent in this conception of the early childhood curriculum is the notion that children construct their own meaning and therefore need educational environments that encourage them to be very active participants in their own learning. The curriculum is seen as a matter of negotiation (Boomer, 1982), to which the teacher brings broadly stated intentions for children's learning, but within which children are empowered to make many of the finer decisions about precisely what to investigate, how to proceed, and ultimately, what is learned.

Another cornerstone of the approach is the teacher's belief in the value of children learning through play. It is play that motivates children to bring into action what they know already, and to problematize and thus identify what needs to be known in order to play on at greater depth and complexity.

Recent approaches to early childhood language education such as emergent literacy (Strickland and Morrow, 1989) and the conference approach or process approach to writing (Calkins, 1994; Graves, 1983) are compatible with these child-centered or child-responsive perspectives on the curriculum. In the language arts, as in other areas of the curriculum, the teacher's role is largely one of facilitation of children's learning—creating environments that stimulate children's ideas and that support children as they pursue those ideas and build their knowledge and skills as authentic language users.

Computer Use in Early Childhood Language Arts

Given the philosophical underpinnings of the holistic curriculum as reflected in the early childhood language arts program, it is appropriate to ask whether the use of computers by young children is compatible with this approach. After reviewing the guidelines for early childhood curriculum described by the National Association for the Education of Young Children, and the literature on the use of computers by young children, Clements, Nastasi and Swaminathan (1993) suggested that there are both appropriate and inappropriate uses of computer-based programs in early childhood education. Inappropriate uses included drill and practice programs. This type of program reduced children's control over their own learning and, it was feared, might lead to less creativity. Appropriate programs for young children were found to have two essential characteristics: the software was open ended and the child was in control, not the computer. These types of computer programs, such as primary-level word processors, are in keeping with child-responsive approaches. When integrated with effective teaching and writing strategies, this type of computer use encourages young children to experiment and communicate through written language. In addition, Clements *et al.* noted high levels of oral language and cooperation as young children interacted at the computer.

As young children move towards more sophisticated use of symbols in their communication with others, they gradually shift from predominantly visual images as in drawings and paintings, to greater use of letters, numerals, or other more highly abstract symbols of their culture, as in formal written language. Recent advances in computer software and hardware are now providing powerful tools to help children represent their ideas and concepts during this time of transition, as they allow for both graphic and linguistic forms of symbolization. New early literacy software such as *Kid Pix* and *Kid Works II*, support children's curiosity, exploration, and creativity and thus are both developmentally and philosophically appropriate.

Because of the recency of these new programs, students in undergraduate teacher education are unlikely to be familiar with their capabilities in the early childhood classroom. This provides a new challenge for teacher educators; to help undergraduate students become familiar with the capabilities of this software and also become enthused with the opportunities these offer for creative learning and teaching.

Providing Learning Opportunities Utilizing Computers in Teacher Education

Early childhood educators face particular challenges in teacher education, when they try to put into their own practice as teachers that which they advocate for the teaching of young children. Clearly, it is neither possible nor desirable to treat college students like preschoolers or first graders. But it is possible to design learning environments for college students that are based on assumptions about them as constructors of their own knowledge, and to try to design learning environments that are appropriate to their level of professional development. These learning environments too, can be characterized by a level of negotiation about curriculum, and the college teacher, like the early childhood teacher, can approach these negotiations with some broadly-stated intentions, and a flexible attitude as to how requirements might be met.

With these shared philosophical and practical commitments, the design and implementation of this innovative integration of two undergraduate courses was guided by the following goals.

1. To involve students in a creative use of the technology, in hope that they would utilize similar approaches with young children in their own classrooms;
2. To provide students with first hand experiences of process writing using *Kid Pix*;
3. To experience the complexity of writing children's literature - appreciating the difficulty of producing what on the surface appears to be a simple story;
4. To observe real-world practices with young children and technology so as to ascertain the characteristics of a successful model of the integration of technology in early childhood education.

There were two major components of the integration: a systematic exploration of uses of computers in early childhood classrooms and writing and illustrating a children's story using *Kid Pix*. The writing of a children's story using Kid Pix will be covered first.

The *Kid Pix* Task

In a writer's workshop, which for the most part was located in one of the campus computer labs, students were encouraged to select topics for their stories, discuss their ideas with peers, compose and share early drafts, provide and receive feedback on each other's pieces through peer and teacher conferences, and revise and edit their subsequent drafts.

Prior to beginning their own writing project, in the Language Arts class meetings, students read and discussed high quality children's literature, and analyzed the components of picture books that contributed to their suitability for and success with young children.

Technology was presented as an integral part of the writing process. For example when students were ready to create the illustrations for their stories, they discovered and shared the drawing possibilities of the *Kid Pix* tools. Consequently, they learned to use *Kid Pix* as they illustrated each page of their stories.

Through participation in the *Kid Pix* task, students had a real reason to look closely at children's literature. No longer was this an abstract topic of dubious practical worth. Understanding the relationship between text and illustrations, questions about characterization, the amount of detail necessary to carry the story, vocabulary, problems of openings, closings and transitions, suddenly took on a new and highly relevant meaning, as the students struggled to solve their own personal problems as authors. At the conclusion of the project they also felt the pride of authorship, as they took their published versions to a first grade and shared the products of their labor with an eager audience.

In struggling with the demands of this new language system, they also gained new appreciation for what young children endure as they master written language. In the lab, the frustrations of the students often were evident. The program "was difficult'" and "time consuming", the practical problems were many, and even writing half a dozen words and fitting them neatly on a page could be a real challenge. In part, this was due to limitations of the text editor in *Kid Pix* which would allow only a short paragraph of text per page. Erasing of text also was a source of frustration. In this way, the use of this unfamiliar technology helped put the students in touch with what it felt like to be a novice symbol user, and although not always comfortable or enjoyable, this experience was very valuable; one that would have been difficult to provide using any other strategy.

Although there are some key differences in how college students learn, compared to young children, we were able to create an environment in which the early childhood majors were supported as constructors of their own knowledge. They were encouraged to explore, and to solve problems collaboratively. They were invited to play with their ideas and with the software, a rare experience for college students. Learning to use *Kid Pix* provided them with many first hand experiential examples of the joy of discovery and creation, and the pleasure of recognizing their own construction of knowledge. Students were happiest when they learned by exploring, for example, by clicking on tools in the drawing palette and trying them out.

Kid Pix provided a wonderfully safe environment for learning to draw with electronic tools and our students accomplished much through the creation of their own images. However, some things could not be learned easily by discovery, such as which disk to use to save work to, or how to copy a background from one picture and paste it on another. They also found it difficult to continue independently when something did not work as planned. We found that more complex sets of procedures were best explained, then distributed in written form. When the same question recurred frequently, the practical solution was to briefly interrupt everyone, and explain the information to the entire class rather than endlessly repeat it to individuals. In short, as these students learned to use *Kid Pix*, we all learned practical strategies about how best to introduce children to unfamiliar software. How much is best left to discovery, and how much needs to be taught directly? We found that college teachers need to be just as sensitive to the extent and timing of their interventions as early childhood educators do in their preschool and primary grade classrooms.

In a number of important ways, the *Kid Pix* story task that was devised provides a good example of one component of a holistic teacher education curriculum. It integrates knowledge from many sources for a practical purpose that is loosely defined by the teacher, but refined and shaped by the students. It recognizes the students as constructors of their own knowledge, and much of the learning that occurs is experiential, rather than abstract. One of the hallmarks of sensitive child-responsive early childhood teaching is the teacher's ability to step into the shoes of the child, and understand what is going on from the child's perspective. This task provided a powerful opportunity for these college students to step back into the shoes of the beginning writer and work through an early literacy experience over an extended period of time.

Systematic Exploration of Uses of Computers in Early Childhood Classrooms

The second major component of the integration involved observation and analysis of current uses of computers in early childhood classrooms. It is important to understand that observation is seen as a critical component of the teacher's professional skills in early childhood education. It is through observation that the teacher comes to know individual children, not only in terms of their developmental abilities, but also to know them as whole people, with prior knowledge, particular needs, and important interests. As observation also plays a substantial role in evaluation—of individual children, of program decisions and the teacher's own actions—it is especially important that student teachers have many opportunities to hone their observation skills and to utilize observations for practical curriculum purposes.

Providing primary level sites for observations where both pedagogy and technology reflect developmentally appropriate and child-responsive practices in language arts was considered very important. Researchers (Calderhead, 1988; Hoy and Woolfolk, 1989; Kagan, 1993) have found that student teachers are likely to adopt the beliefs and practices of their cooperating teachers, rather than their university professors. Despite our desire for carefully selected sites for observation, only about two thirds of the students utilized these sites. The others visited unscreened schools that were more convenient to them.

The students completed a formal anecdotal observation of one or two children aged 5-8 years, who were doing some form of early writing using a computer. Earlier, the students had been taught the art of observing children in early preschool and primary age classrooms. Just prior to the observation, students read and discussed cases of teachers using computers for early writing (Cochran-Smith, Paris & Kahn, 1991). The structure of the interpretive comments for our students' written anecdotal observations also were adapted from the categories these researchers used in their report: the role of the teacher; the lab vs. classroom placement of computers; the type of activity (skill/drill or composing); the management and monitoring of the activity; and the use of oral language—especially if children were working in pairs or conferring with neighbors, and composing, revising, conferencing, and editing.

A joint debriefing session took place the class period following the observations. The schema used in writing the interpretive comments was used for the oral debriefing and both professors read and commented on their papers.

The observations reinforced the importance of selecting sites for observation. Students who selected their own sites often reported that children were involved in skill/drill programs, or games with a single skill emphasis. Most of these teachers took their classes to the lab for about 40 minutes per week, and students documented that the children often became bored after 10-15 minutes. Nor did these observers find a close relationship between the language arts program and what happened in the computer lab. Lab activities appeared to be separate from the rest of the curriculum.

On the other hand, most of the students who observed in the pre-selected sites found that children were actually writing with the computer and their earlier work was displayed on the classroom walls. The connections between computer based writing and the overall writing program was evident. In the cases where children worked on a computer in the classroom, they noted that often another child was situated nearby who was recognized as "the expert" and she or he was consulted prior to calling for the teacher's attention. As students shared their observations and interpretive comments, several things became clear to them. They observed that many of the children were successful in working with language in constructivist environments. They also observed that there was not one best way to teach word processing to young writers, and that the one-computer classroom was neither better nor worse than the lab arrangement. Rather, they found a variety of strategies that worked under different circumstances. They also found practical problems that they would try to solve (and that could be solved). For example, there were problems in ensuring children were able to finish their writing on the one computer in the classroom, and that all children had an equal opportunity to use the computer for writing. The observation task and the debriefing that followed helped to sensitize students to some of the important issues they will face in early childhood classrooms, and provided some ideas about how to resolve them.

Evaluating our Collaboration

The teacher education faculty at ASUW has challenged itself to look for new ways to develop and enact its curriculum. For the past 18 months we have discussed various ways of reshaping our traditional curriculum to meet emerging needs. As faculty struggle to design a more powerful set of courses addressing interrelated themes, questions have been voiced about how best to provide learning opportunities in the area of computing. For example, should technology be a separate course or should technology be infused in every course? Are ideas infused or professors? How far can you stretch technology support professors if they are providing support for many courses? Strong arguments can be made both for separate technology courses and for integration of technology in all methods courses by the instructor of record, and it is not yet clear which path our faculty will take. But in the interim, we have taken another initiative—that of maintaining the regular structure for our two separate courses, but additionally engaging in team planning, arranging some class sessions in common, and negotiating some joint assignment tasks.

From the perspective of these two faculty, this has been a highly successful collaboration, not only of two college courses, but also as an integration and application of technology in the classroom. Unlike some other forms of technological integration that are being suggested, this approach was characterized by equal power sharing between us, and we believe this was a key to its success as an integration.

Another area of concern was ascertaining student responses to the new integrative approach. Although observations of students and journal entries provided some anecdotal evidence of what they learned from the integration, in the future we need to get more information about student perspectives and more substantive information about what they learned from the total experience.

Recent Modifications and Directions for the Future

There are several technology modifications that will be made before we teach in this way again. Although *Kid Pix* served our purposes, and the graphics component was outstanding, we will be searching for more appropriate programs or combinations of programs, particularly in terms of word processing. For young children, the *Kid Pix* text editor may be appropriate, but the adults pushed it beyond its capacities. In the future we will try using *Kid Pix* for the illustrations, but combine it with The Writing Center, for text creation. The Writing Center can insert *Kid Pix* pictures into the body of the text. Although this adds some additional steps, we feel the expanded capacity for text generation and editing will provide fewer restrictions on our students' creativity.

Secondly, we want to expose our students to the use of computers for topic research and expository writing as well as creative writing. The writing and drawing tools would remain, but we plan to include data collection from electronic information resources such as children's dictionaries and encyclopedias on CD-ROM. This information (text and pictures) will be used as they construct a science or geography report.

This collaboration should continue through the development of new curriculum models for our undergraduate teacher education program. We believe it holds promise as a way to integrate technology in a way that is consistent with the early childhood philosophical approach described.

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Virtual Field Experience Utilizing Computer Networks and Interactive Television

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"By communicating with the eighth grade class, it brought in a realistic perspective that I could tie in with all my theory content methods classes. It helped bring everything together in a whole new context that was alive and real."

The above quotation is from a response paper written by a preservice teacher in the School of Education at Iowa State University who participated in a research study where we used computer telecommunications and the interactive distance education facilities of the Iowa fiber optics network to link eighth graders and preservice teachers enrolled in a secondary reading methods course. This combination of technologies allowed the students to use written, voice, and visual communication to connect with each other.

I hypothesized that this experience would increase the opportunities of preservice teachers to interact with middle school students, would expand their knowledge of what students that age enjoy reading and writing about, and would develop confidence in their ability to respond to the writings of this age student. The second hypothesis was that the college students would utilize technology and feel more competent when communicating via computer online technology.

Using Technology to Increase Student Contact

Beginning teachers often complain that they feel unprepared for the challenges they face in their first classrooms. According to Denton (1982), the preservice teacher may see early field experiences as a beneficial training in preparing them to teach. Increasing the students' field experiences in preservice education curriculum should serve to increase the confidence level of new teachers. However, the early contact experiences that preservice teachers have with schools needs to be reflective and under the auspices of their college instructor (Goodman, 1986). The utilization of online networks and distance education classrooms can create a virtual field experience and is a very feasible, cost effective way to increase preservice teacher contact time with students in an environment where the college instructor can monitor and guide.

The ability of preservice secondary teachers to interact with middle school students in a virtual field experience, using online networks and interactive television, suggests that this technology allowed them to evaluate and learn what students at this age read and write about. The technology allowed a one-to-one interactive arrangement that gave the preservice teachers a chance to understand the students with whom they were paired and to follow the students' development and growth as readers and writers throughout the semester.

This virtual field experience is similar to the functional learning environment described by Newman (1987) and Riel (1991) which includes word processing, social interaction, and telecommunication networks that in combination create authentic literacy events that motivate students to use written language for communication. Text-based communication that is computer-mediated is interactive and requires active involvement of the participants (Harasim, 1990). This new language environment that uses online and distance education allows students to communicate with readers who are different ages, background, and education (Riel, 1991; Hawkins & Sheingold, 1986).

Description of the Study

The participants in this study were 55 preservice education students enrolled in "Teaching Reading in the Secondary Schools" in the fall and spring semesters at Iowa State. The fall semester had 27 students involved in the activity and the spring had 28. The study measured the number of exchanges, as well as the length and the nature of the written exchange initiated by the college students.

During the first phase, the eighth grade teacher paired each of my college students with one of her students. The online network communication was established between the middle school and the college class using America Online and Internet respectively. All the college students received access to Internet and e-mail addresses. The eighth grade class used the commercial network, America Online. The college students made the initial contact with their assigned computer pals by sending an informal message in which they described themselves and asked questions of the eighth graders. Also, during the initial phase, photographs were taken of all students to exchange with his/her assigned computer pal. Next, there was a "face to face" interactive meeting using the Iowa Communications Network (ICN) distance education classrooms.

The eighth graders and the college students had two meetings in the semester using the ICN classrooms. The first meeting occurred in the third week of the college semester and the final meeting during the last week of classes. The online ICN meetings were one hour in duration with the first meeting used to introduce the students to each other and to find out about personal background, school involvement, and reading interest. The second and final ICN meeting was more focused, with the eighth graders asking the college students about college life. The college students formed five panels of four each and took a ten-minute time at the "controls" to answer the eighth graders' questions.

A pre- and posttest questionnaire was used to measure perceived change in knowledge about middle school students and their language skills. The objective for the college students was to increase their confidence level in using technology and in working with middle school students.

The major factors of interest were whether or not the preservice students would see the potential and utilize the opportunity to interact with middle school students using electronic mail and the interactive televised meetings. Overall this experience seemed to have contributed to a change in the preservice teacher's perception of students in this age group and it was viewed as a positive experience by most of the students. Due to several delays and problems in the first semester, this report will focus on the results from the second semester.

There were 28 preservice teachers, 11 males and 17 females who participated throughout the second semester exchange. The study analyzed the number of e-mail messages sent by the college student and voice of the writer used in the communication. The college students also wrote a final paper to summarize their attitudes toward the experience and their reflections as to the value of the computer-pal exchange.

There were a total of 152 messages sent by the 28 students. This is an average of 5.42 messages per student. The frequency of messages sent ranged went from a low of 1 to a high of 13 over the 12 weeks of the spring semester. The most often occurring frequency was eight.

The voice of the author of the messages was classified as "friend", "teacher/older friend", or "critic". Twenty-two of the 28 students used a "teacher/older friend" voice with the eighth grader. They seemed be able to relate as an adult and saw themselves in the role of "teacher" but could also respond as an older friend to the eighth grader. They combined the role of teacher and friend asking and responding to questions on a personal level and moving back to the teacher role and asking questions and talking about the reading as well as writing and other classwork that their eighth grade partner was doing.

For a few of the preservice students, there seemed to be problems adapting to the teacher/older friend role. Two students seemed to relate only as a friend or "sister" as they described the experience. One of these pairs began to write to each other outside the classroom and reports indicated that serious adolescent problems were discussed. At the other extreme were three preservice teachers who did not seem to be able to relate to this age student at all. They remained distant and the exchanges were very formal and stilted. One of these students sent an e-mail message to his eighth grade penpal that was a critical analysis of a postmodern text that he was using in his college class. One student had only one exchange with her penpal and felt the technology was "too difficult" for her to learn.

The study also used a questionnaire to determine if there were changes in how the students perceived their knowledge and confidence level regarding sending e-mail messages and understanding the reading and writing interest of middle school students. Nineteen students completed both the surveys. The survey included 14 items that students responded to on a Likert scale of 1 to 5 with 1 being "not knowledgeable" and 5 being "very knowledgeable." The difference in the means of four of the representative items is reported in Table 1.

Table 1. Selected Survey Item Response.

	Survey		
	Pre	Post	Change
Ability to send e-mail message	x=2.21 sd=1.54	x=4.21 sd=0.83	+2.00
Ability to respond to writing	x=3.16 sd=1.05	x=3.94 sd=0.51	+0.78

Reading interest of eighth graders	x=2.89 sd=0.91	x=3.89 sd=0.78	+1.00
Writing ability of eighth graders	x=2.63 sd=0.87	x=3.78 sd=0.76	+1.15
Motivating reluctant readers	x=2.63 sd=1.03	x=3.68 sd=0.72	+1.05

Students' Reflections and Reactions

Twenty-seven of the 28 students wrote a final reflective paper explaining their reaction and analysis of the experience. Of these reports, 23 students reported their reactions to the project as positive or very positive and four students defined the experience as negative.

The following quotes are taken from these written reports and exemplifies the general self assessment of the project by the students:

Both the writing and the meetings over the ICN were helpful experiences to prepare me for future teaching. The writing let me get back into the mind of an eighth grader.

The ICN meetings were a lot of fun. Being able to see and talk to the person you're writing to makes corresponding much more easy. The second meeting was unbelievable! The students opened up so much compared to the first time.

Overall, I thought this was an excellent opportunity to learn about new technology and about junior high all at once. The correspondence was a lot of fun and very worthwhile.

My experience with the computer pal was very helpful. It gave me a chance to see an eighth-grader progress throughout a semester..

I was sure that I never wanted to teach junior high level kids. I had convinced myself that they would be too immature, and that they would drive me crazy. After taking part in this exchange however, I have seen that they are really a good group of kids to work with. They seem motivated and excited to learn, and they are a lot more mature than I previously thought. I am now thinking twice about getting into this age level of teaching.

Conclusion

This study attempted to create a virtual field experience for preservice teachers to interact with middle school students to observe their reading, writing, and communication skills. They were able to follow the eighth grade penpal through fourteen weeks of the school year. One of the most common comments in the written responses was "I had forgotten what it was like to be in the eighth grade." Some of the college students' comments about the level of activity and excitement of the eighth grade students indicated that they had a new awareness and appreciation for this age student.

The results of the attitude survey indicated that there was a positive change in both the ability to utilize technology tools and in the ability to assess the needs of eighth graders as readers and writers. These findings suggest preservice teachers can benefit from online experiences with students when there is focused activity, such as an emphasis on reading and writing skills, and when there is time for reflection and self-evaluation by the preservice teacher.

The results of this research should contribute to the knowledge of how online communication and distance education can be utilized in the teaching of undergraduates in education. There are immediate implications for technology integration in the teacher education curriculum and for the collaboration of preservice teachers with students in middle schools. With the information gained from this study, there are indications that further studies could explore the possibilities of utilizing technologies to widen the early field experiences of preservice education students. The preservice curriculum for teachers of reading in the secondary schools and middle school language arts curriculum could be modified to include early field experience contact while students are still under the auspices and direction of the university instructor.

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A Model of Learning to Teach Writing with Computers

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Whitewater

Computers have provided many alternatives to enrich instructional activities. There are many programs which can be used to teach in math and science; however, computers are also a wonderful tool for teaching the language arts, such as writing. This paper will discuss some of the relevant kinds of programs to accomplish this and will present a model of how to integrate them effectively into writing instruction. It will include the following: a) a brief discussion of the many kinds of software programs to support the teaching of writing; b) a description of a summer workshop for teachers integrating some of the software; and c) a model of a technology-enriched writing process.

Software for the Writing Process

Writing is a process of thinking and problem-solving consisting of a recursive series of steps (Flower, 1981; Perl, 1994). Quality writing requires extensive discipline. To get ideas well-organized and expressed, writers need to know how to get inspiration, draft, revise, confer with peers or teachers, edit, and publish. With the help of computers, these tasks become much easier and more encouraging. Software programs for writing provide capabilities which are much more powerful than a typewriter. Many software tools help students organize their ideas better and concentrate on the content they want to convey instead of the structure only.

Word processing, and, to a lesser extent, database, and spreadsheet software programs are now widely used in schools to enhance writing instruction. Computers have been used in writing instruction mainly to facilitate composing, editing, and revision. Teachers use computers to help students avoid the most tedious aspects of copying and rewriting that are a part of process-oriented classes. However, other uses of computers in writing are less well-known. Newer computer technologies such as multimedia, hypertext, and telecommunications, which promise an even more optimal enhancement to writing instruction, are just now gaining the attention of teachers.

A Workshop for Teachers

To help teachers explore both commonly available software and the more advanced technologies, we held a week-long summer workshop in New Technologies for Writing Instruction. The workshop, sponsored by Prentice-Hall publishers, allowed us to refine a model for integrating technology as well as to consider effective ways of introducing technology to teachers. In the workshop, 24 teachers looked at various applications in the context of their own writing and teaching. The centerpiece of the workshop was a prototype multimedia program, *The Writer's Solution*. Part of the workshop consisted of the teachers, in groups, writing critiques of the prototype to be read by the developers. Participants engaged in hands-on computer activities and composed an article by going through the typical writing processes using computers as an aid. Teachers thoroughly discussed the relationship between technology, writing, and teaching using their own experience as a background.

In addition to testing the prototype, the participants used, or viewed demonstrations of, a variety of other kinds of software. They used a word-processing program for their individual and group writing. Also, they experimented with multimedia and publishing programs. (Some of the more experienced computer users in the group spent much of their discretionary time producing creative multimedia works with one program.) Some of the less familiar applications that teachers looked at included programs for idea generation and outlining, speech generation, text analysis, and electronic mail. For the workshop, each participant received an Internet account. We looked at resources on the Internet as well as those on commercial online services for education.

Teachers found the workshop helpful for several reasons. An emphasis on collaboration allowed participants with better computer skills to help others who were less expert. Making the teachers' own writing the focus of the workshop gave participants a direct understanding of how their students might experience a technology-enhanced writing process. In doing this, we were following the model established by Gray (1988) in the National Writing Project. Through their active participation in writing essays, stories, critiques, and other genres with the computer, the teachers deepened their understanding of both writing instruction and software design.

A Model for Teaching Writing with Computers

In our discussions with teachers, we began to see how different kinds of applications complemented different phases of the writing process. One thing that became clear was that it is now possible and necessary to think of the whole writing process, and not just specific tools for discrete activities, when considering how to use technology in writing instruction. For greater efficiency as well as effectiveness in teaching, it is important to get the "big picture" and think of technology as an integral part of instruction. This is not to say that the ideal program for writing instruction is a single, comprehensive package including all possible tools, but rather that teachers can carefully select from among a variety of available programs and assemble the set of programs that best fit their teaching goals.

To effectively integrate technology into writing instruction, the following elements need to be present:

- Identification of software programs to complement each stage of the writing process
- Freedom for teachers to choose the best software for them
- Active, hands-on use of technology by students
- Cooperative learning—both learning to write and learning to use computers
- Moving beyond basic editing as the only stage for computer use
- Moving toward advanced publishing as a goal in writing and as a type of software
- Focus on the quality of writing, not just speed and efficiency
- Focus on giving inspiration rather than making corrections
- Emphasis on interactivity between users and programs, as well as between users

The following model (as shown in Figure 1) illustrates how specific kinds of software programs complement individual phases of the writing process. Using this model, teachers can get an idea of the full range of possible technological enhancements at each phase.

Issues in Implementing Technology throughout the Writing Process

What Kinds of Programs?

Software for writing instruction falls into two broad categories. One type might be called *tools to support writing*. Examples of this type would include *Writer's Helper* by Conduit and *Inspirations* by Inspiration Software. Both of these programs are designed to help writers in specific ways at specific points in the writing process. The other type, represented by Prentice-Hall's *The Writer's Solution* prototype, resembles *programmed instruction* or traditional textbooks in its comprehensive presentation of information, structured learning activities, and versions for specific grade levels.

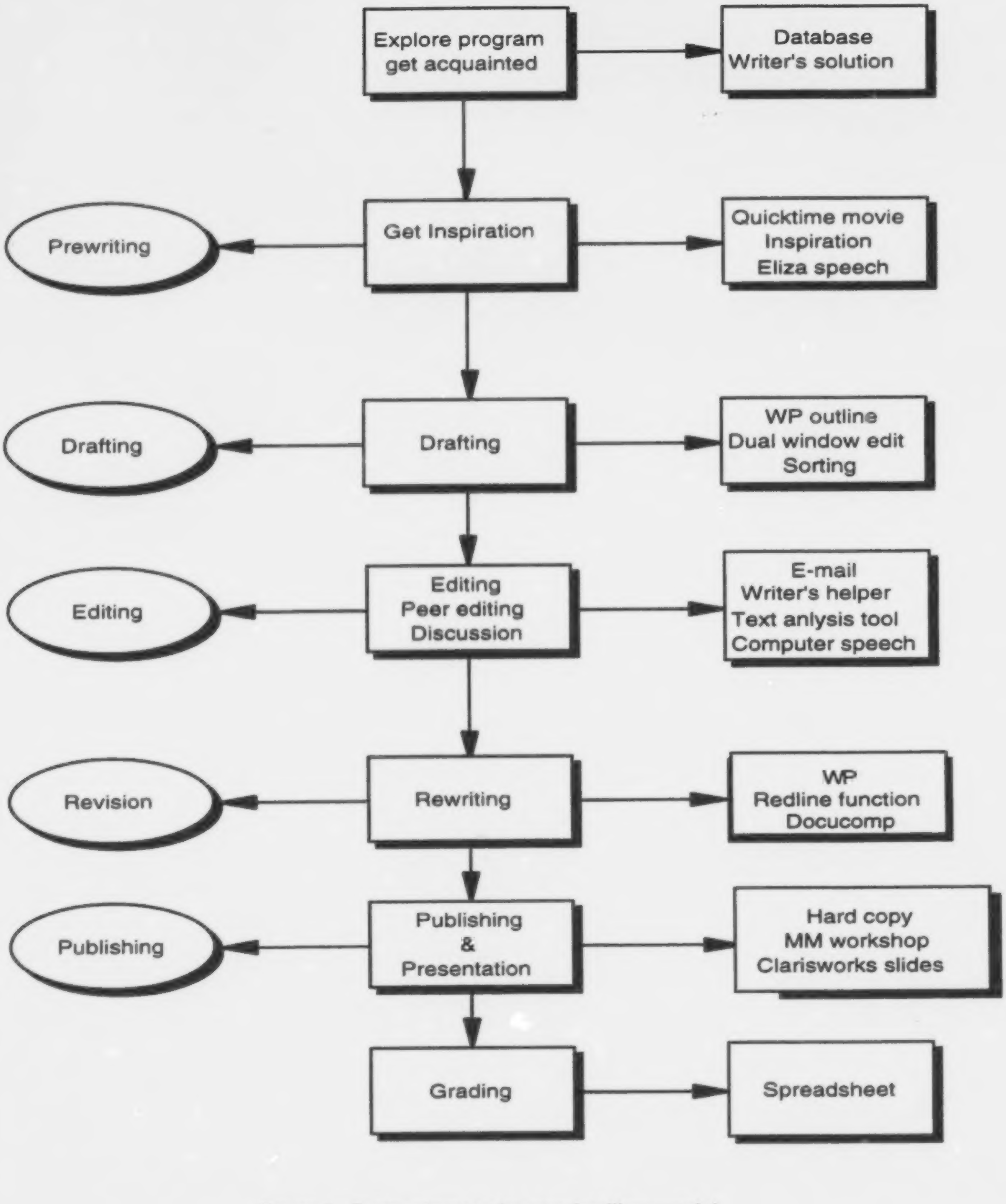
Teachers in our workshop seemed to find more use for the support tools than for the more textbook-like aspects of *The Writer's Solution*, even though *The Writer's Solution* was far more sophisticated with its use of multimedia and hypertext than the other programs were. This may have been because *The Writer's Solution* was just too overwhelming in its comprehensive inclusion of word processing, handbook, textbook, multimedia, and other features, and not because the teachers were philosophically opposed to more comprehensive programs. This question bears further investigation, however. Simply adding multimedia, sound, and other advanced technological features did not necessarily make the software more appealing to teachers, though teachers did not consider these features drawbacks in any way.

Difficulties in Implementation

Teachers in the workshop mentioned numerous difficulties they experienced or anticipated with computer use in their own writing instruction. Insufficient time to implement, lack of administrative support, inadequate equipment or facilities (one teacher described his difficulty with a computer lab located in the school library), lack of software, and other considerations all stood in the way of teachers making the best use of any software. As with any use of technology in the curriculum, computer applications in writing instruction require time and technical support. Acquiring appropriate software is often just the first step in establishing an effective instructional program.

Management Issues

Some of the most animated discussions of the summer workshop were about how to organize students' computer use. Teachers were concerned about monitoring students' progress—they wanted to know whether students in the lab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E-mail Writer's helper Text anlysis tool Computer speech
Revision
Rewriting
WP Redline function Docucomp
Publishing
Publishing & Presentation
Hard copy MM workshop Clarisworks slides
Grading
Spreadsheet

Figure 1. Technology-enhanced writing model.

were doing homework, writing their own papers, or playing games, copying others' papers, etc. Vandalism was also a serious concern. Some schools have resorted to restrictive measures to protect machines, creating a sterile, laboratory atmosphere and, in one case, even denying students access to electronic mail on their local network because some had sent abusive messages. However, such measures may not be the only alternative. One workshop teacher suggested that by letting students personalize their computers and treating the computer area as a comfortable, friendly place, teachers at his school gave the students a sense of ownership that led them to take greater responsibility for the machines.

More basic management issues included how to make computers accessible to students. In many schools, the total number of machines is still limited, and computers are placed not in classrooms but in some central location such as a lab, library, or learning center. In the workshop, we demonstrated the use of an LCD panel to make multimedia displays accessible to the whole class. We also showed how pairs of students could work at single machines and how students could rotate among basic and more advanced work stations depending on the work they had to do. For example, in one week, all 24 workshop teachers learned to use the high-end multimedia computers even though only eight of these were available in the lab.

The Teacher's Role

Many teachers have noted in the past how adopting a process-oriented form of writing instruction, with its emphasis on peer sharing and choice, requires a greater delegation of authority to students than students might be accustomed to. This is even more true when writing is combined with computer use. Much of the learning that takes place in this model of the writing process requires independent activity by students. In our workshop, teachers often could decide among themselves which projects to work on at a given time, or how to organize their collaboration. We anticipated that their students, too, would need some of the same kind of freedom in order to make the best use of technology in their own individual writing processes. The part of *The Writer's Solution* prototype that involved self-paced and self-guided writing using hypertext links was a good model for this kind of student-centeredness.

Teachers may also experience a need to negotiate their authority in relationship to the computer programs, and not just in relation to the students. This is particularly true when using programs of the textbook or programmed-learning variety. For example, several of the teachers in the summer workshop were confused about the role of the multimedia prototype program because it was difficult to determine where the teacher fit in. Though perhaps willing to take an indirect role in students' writing processes, teachers had a hard time relinquishing their whole curriculum to a hypermedia program, no matter how advanced. Teachers were eager to be able to customize or modify the software so that it fit better with their curricula or their style of teaching. For example, teachers wanted to be able to include their own pictures and model essays in *The Writer's Solution* prototype.

Staff Development Issues

The same features that make a good technology-enhanced writing curriculum also can help teachers learn how to teach writing with computers. Focus on the writing process, hands-on use of computers (*and* plenty of actual writing), freedom of choice, and extensive collaboration all contributed to the success of our summer workshop. Successful implementation of technology often hinges on adequate instruction and follow-up for teachers. When implementing technology in the writing process, teachers also benefit from direct experience of how technology can make writing easier and better. Our workshop succeeded in part because teachers informally supported each other's learning and continually made connections between the technology in the summer program and what was available to them in their own schools.

Conclusion

There is tremendous unrealized potential for the application of computer technology to writing instruction. This potential will start to be realized when teachers develop a sense of the whole writing process and the specific points in the process where various software programs can be used effectively. Helping teachers gain access to this knowledge, and not just to knowledge of specific programs in isolation, is thus an important function of staff development in technology. The summer workshop we describe, in which the writing process itself served to organize teachers' learning and technology served authentic purposes within that process, showed one potentially powerful way that this could be done.

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Children's Literature: Linking Books and Technology

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While the realities of school classrooms put constraints on the use of technology, the availability and application of technology in the classrooms is improving. As technology is slowly being integrated into public school classrooms, university programs that prepare teachers are being charged with the responsibility of training new teachers to enter the classrooms ready to teach with technology. The training of preservice teachers is an important step in the implementation of technology into the schools. Beginning teachers must be effective, computer-using teachers who are comfortable and familiar with new technologies. These new teachers must be competent in using technology to its full potential in everyday instruction. This integration of technology has posed a definite challenge for teacher educators.

In reflecting on the difficult task of preparing technology-literate teachers, it becomes evident that the coursework taken by preservice students must be restructured and designed to make technology an integral part of instruction and assignments. The process of restructuring preservice teacher coursework to meet the current emphasis of technology in the public schools began in 1991 at Our Lady of the Lake University (OLLU) when we became a collaborative partner in the San Antonio-based Texas Professional Development and Technology Center. This center is committed to collaboratively providing field-based teacher preservice education, staff development, and learning opportunities using state-of-the-art technology (Texas Education Agency, 1993).

Obstacles To Technology Integration

While we knew that the training of our preservice teachers in technology was the key to a successful effort to integrate technology into teaching, two major obstacles at Our Lady of the Lake University stood in our way. One major obstacle to be overcome in the integration of technology into our coursework was the lack of hardware and software available to train preservice teachers. However, with the financial support provided by the Texas Legislature for the Professional Development and Technology Centers, OLLU was able to design a state-of- the-art technology classroom at our demonstration school. This technology classroom has a computer lab with both MAC and DOS based machines, an extensive variety of software, CD-ROMs, laserdiscs, and a multimedia production and demonstration center. Access to telecommunications, distance learning, and video conferencing is also available.

The other major obstacle was the lack of technology knowledge and training by university faculty members. Again, with funding from the Texas Legislature, we were able to provide consultants and training sessions to help university faculty become more proficient with technology. Also, a part-time technology coordinator was hired to oversee the training in the technology classroom. Modeling the use of technology in teaching became a high priority among education faculty members.

Children's Literature Course Description

According to Valmont (1994), it is time to ensure that preservice teachers learn about electronic books. Since one of the first courses taken by most elementary preservice teachers at OLLU is the children's literature course, I decided that this was the perfect course within which this exposure could occur. I also made the decision to completely restructure this course through the use of technology since the arrival of the Information Age has brought with it a vast amount of literature stored on Compact Disc Read Only Memory's (CD-ROM). Electronic encyclopedias, static picture books, moving picture books, and multimedia books are providing readers with an electronic alternative to the printed page (Barker and Giller, 1991). New teachers need to be familiar with and knowledgeable about the use of electronic books, as well as conventional books. Working from this premise, the children's literature course, offered at both the undergraduate and graduate level, was designed to integrate traditional literature formats and advanced media technology (i.e., interactive and Discis electronic books, multimedia presentations, and children's literature databases) so that our early childhood/elementary preservice teachers would be prepared to use technology to create an exciting literature experience for their students. In the summer of 1994, the first technology enriched children's literature course was offered.

Instruction

Teaching with technology changes the nature of teaching and learning methods and models. Keeping this in mind, I designed lessons for the technology enriched course using a multimedia application of Linkway Live! By modeling the use of this technology in teaching the course, I was able to expose the students to practical strategies for implementing technology into teaching and for creating a new type of learning environment within the classroom. Students were also given training in the utilization of multimedia which included both Linkway Live! and Hyper-Studio. Creativity and exploration were encouraged during these sessions.

Assignments

Assignments for the restructured children's literature course were carefully examined to ensure that technology was a priority for each assignment. Designing lessons and presentations using a multimedia format was a major objective. To meet this objective, an oral presentation of a children's book using Hyper-Studio became one of the major instructional focal points. Cooperative group discussions included a variety of technology issues such as the differences between conventional books and electronic books, a theoretical framework for evaluating electronic books, and recommendations for improving the implementation of electronic books in elementary and secondary schools. The students also critiqued an interactive electronic book, *Just Grandma and Me* and a Discis book, *The Paper Bag Princess*. Students were also required to create a children's literature database for their future use.

Future Directions

Discussions with students revealed positive reactions toward the course. They felt that the exposure to multimedia and electronic books was extremely valuable. However, the major complaint from students was the great amount of time needed to become proficient on the computer, learn the multimedia programs, prepare the presentation and learn the course content. Students were spending anywhere from five to ten hours a week extra in the technology classroom. While preparing preservice teachers to use this technology remains a major goal of the children's literature course, the issue of time constraints will have to be addressed before this course is taught again. However, all thing considered, the course was a success and we are on our way to preparing teachers who are comfortable with and excited about technology in the classroom.

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Creative Uses of E-Mail Texts in Foreign Language Teaching

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In some earlier research, students of the Carl von Ossietzky–University in Oldenburg verified that e-mail is a medium which enhances the possibility of teaching English in a way that enables pupils to use a foreign language as a means to cause actions and emotions in themselves and in others (Rautenhaus, 1993).

Teachers, however, need examples of techniques that can be used successfully in planning new teaching units around existing e-mail texts These examples should be such that teachers' creativity is encouraged.

This was the starting point for a seminar taught at the Carl von Ossietzky–University in the winter semester of 93/94. The aim was to improve the flexibility and creativity of student-teachers, with respect to teaching methods in foreign language teaching. It is important to prevent the traditional models of teaching from degenerating into stale routines which make lively innovations impossible. Therefore the following (cognitive and affective) aims were set for the seminar:

- identification of the possible functions, forms and effects of teaching materials which teachers themselves prepare
- knowledge of general and specific techniques for organization and development of foreign language teaching materials
- development of a general readiness for, even perhaps the "fun" of, taking the trouble to prepare one's own materials.

The students worked in groups studying different techniques and the application of those techniques. In this paper I will deal with the results of the group working on "creative handling of e–mail–collections".

The Texts Used

The texts used came from an international project centrally organized by John Meadows, which took place during the period November, 1992 to April, 1993. *Global Stories* began as a literature exercise, consisting of a set of ten questions sent out electronically to schools in about twenty countries through the medium of Campus 2000. One of the questions asked pupils to write or rewrite stories from their own cultures and send these to the organizer. It turned out that this question was the most popular among pupils and teachers. The organizer then edited the stories, on a technical, not linguistic, basis and re-sent them to all participants, through the use of e-mail blind-copies. The complete set of stories was also stored on an electronic database, part of the Campus 2000 international database.

Preparing the Texts

The most important part of our seminar was the process that student-teachers went through in preparing materials, rather than the final products they prepared. The report below concerns only the results from the group working on the creative handling of the e-mail collections mentioned above. The students in this and all other groups experienced considerable initial problems. The challenge of being creative seemed to handicap them and only after considerable clarification were they able to proceed with their work, i.e. to ask independent questions, explore alternative solutions and develop original materials. They needed reassurance that anything was allowed and that there was no set standard to be achieved; in this situation, there were no right answers. However, they had to realize that they still needed solid knowledge and ability in language, pedagogy and teaching methodology to be sucessful.

In the following I will explain the techniques used by the students to make e-mail text collections usable by means of the computer. This includes both editing and correcting the raw texts, technical methods for finding texts for specific situations, and using the file manager and a program called *Teachware* to identify the degree of difficulty of the text for the pupils the teacher has in mind. Finally I will include practical examples of exercises made for specific teaching situations.

Editing and Correcting the Incomplete Texts

The original version of the *Global Stories*, as I had handed it on disk to the students, could not easily be used in English language classes as it contained many kinds of errors and was not sufficiently organized. There were lots of address codes and mistakes arising from electronic transmission as well as misspellings and linguistic errors. The students used software called *Winword* to develop the texts into a more usable form.

To prepare the second version, students erased address codes, although keeping the place of origin, and used a spell-checker in *Winword*, to deal with many of the errors. This meant they did not need to read the whole text at this stage. However, when the spell-checker was unable to suggest an alternative, they sometimes had to refer to their own dictionaries. Since the program had no grammatical routine, they then had to carry out a manual reading of the texts and remove the remaining errors. Then every text was put into its own separate file.

To prepare the third version, they decided upon key words and used the file manager option to enter these. Key words include things like source, title, topic, names of main characters, place and genre (e.g. legends, fairy tales, etc.). This meant that the stories could now be organized according to a variety of categories and were much easier to handle. In the original Campus 2000 database, the stories had been organized according to their country of origin.

Finding Suitable Stories for Specific Teaching Situations

It was now possible to find a particular story using the information in the file manager. Students, in the role of future teachers, could use the search command to find the relevant story that they might need in a particular class setting. The program would now allow easy selection of appropriate stories.

The students then used a software program, *Teachware*, to further organize and analyze the contents of the stories. *Teachware* is a program designed to be used by teachers, not by pupils. Its main value is that it holds lists of words relevant to particular stages of English language teaching and allows the comparison of words from a story with word lists occurring in particular textbooks, hence identifying those words likely to be new to the pupils. This program is now available under the name *Sprachtext* from the HEUREKA–Klett software house.

Examples of Practical Proposals for Use in Language Classrooms

The following are examples from students' work with the stories. These examples contain specific suggestions for activities that use the e-mail texts, with some examples of the actual texts included.

Example 1: Creative Text Production

This activity fosters independent thinking and cultural understanding. Students would be given a cartoon depicting a story from Argentina and would also be given a word list. They would be asked to take the cartoon home and write a story about it using the words on the list. Later in class, the pupils would read their versions of the story aloud and a general discussion would take place. Only then would the pupils be given the original version of the story, in order to compare it with their own version.

After this comparison, the following additional activities for pupils could take place: The pupils then interview each other about their experiences at Christmas, e.g. "Is there anything special you do at Christmas?", "Do you have a special meal at Christmas?", etc. Possible extensions or homework could be: "Describe how you celebrate Christmas", or "Rewrite Gabriella's story from the perspective of one of the characters involved in the story, e.g. imagine you are one of the three wise men and write the story as he would have experienced it."

The Story. *Argentina: A Christmas Custom from Argentina*, by Gabriella, Age 11, Sacred Heart School, Cabramatta, Sydney, Australia.

In Argentina we celebrate the three wise men. The tradition is to put grass and water with a pair of shoes at the front door. All children go to sleep and when they wake up they find the grass and water gone and on top of their shoes they receive presents. The grass and water have gone as a symbol that the three wise men have come and their camels have eaten and drunk.

Example 2: Re-ordering

This activity aims to improve reading ability and understanding of text. Start by reading the story together, with a copy for each pupil, making sure the pupils understand the vocabulary. Collect the texts. Divide the class into groups, each with about four pupils, then give each group the story, cut into smaller sections (see the symbols in the text below). The groups then place the sections back in the order of the original story.

This re-ordering, or jigsaw procedure is based on the principle of slowing down the reading process so that the pupils have to read each part several times. The decisions about cutting up the text are important. Cuts need to be made in such a way that grammatically possible combinations are determined by the logic of the structure of the story. The story could actually be put together in a variety of grammatically correct ways, but there would be only one correct version from a logical point of view, e.g. the two short extracts from the skeleton of the story, "At nightfall..." and "On the next day..." could be grammatically interchanged, but would not make logical sense. So pupils need to really understand the contextual symbols and the logical structure of the text.

The Story. *France: Saint Catherine Fair* by Mme M., et ses elèves de 4me, college Lucien Herr d'Altkirch.

Every year, in Altkirch, there is a fair which delights all the neighborhood of the town and opens the Christmas season. This feast is the >"St. Catherine Fair". It takes place on the nearest Thursday to St. Catherine's Day, towards November 25. This fair has been famous for centuries: street hawkers come from far away: Allier, Haute Saone, Doubs and some Swiss and German tourists come to visit us.<

It is an important meeting of many people from the whole area, street hawkers, shopkeepers and inhabitants. No one can >drive through town because all the streets are so crowded by the numerous stalls. And we can see plenty of cars on the roads outside town.<

The whole town looks completely different, strange. >We don't recognize the houses behind the stalls. As the cars can't enter the town, the persons and the children who either work or go to school there but don't live in Altkirch can't work or go to school on this day. How lucky!<

Then some pupils can have a stall too: we do it to >raise money; most of us go for a walk in town, have a drink or eat a sandwich with friends. The day itself begins very early in the morning: the lorries enter the town and their owners install at about 6.30 a.m. Many different things are sold at the fair: cattle, cars, tractors, toys, clothes for the winter, furniture, sweets, jewels, all sorts of bread, vegetables and fruit of autumn. There are also many snack-bars for all the people who eat at the fair.<

It's difficult to walk >in the streets: there are so many people, especially in the afternoon. The weather is usually cold and cloudy. So the stalls prepare some coffee, tea or mulled wine, a typical Alsatian drink.<

At nightfall, >towards 6 p.m., the street hawkers start tidying things away. The fair comes to an end. The fair is over but the feast itself is not. In the evening, there is a "Catherinettes" ball. They are the young women aged 25 who are still not married. They must transform a simple hat into a masterpiece and they wear it to show their creation at this ball.<

On the next day >the newspapers print the photos of the nicest and most original ones. Then the fair is really finished.<

From now on, children think of Saint Nicholas which we celebrate on December 6th.

Example 3: Role Play

This short but very impressive story can be seen from a modern, industrial perspective. Pupils can identify the moral of the story and then compare it with situations within their own lives. One could possibly transfer the moral into a modern context, imagine a situation with a similar moral and then act out the story.

Stories from other countries like this one can raise interesting questions and give relevant contexts for discussions. This example could be used to talk about old Chinese traditions and to compare these with the modern Chinese traditions and with those of the pupils' own country. The class could re-establish an e-mail contact with the author of the story and ask her if the story could still take place in modern China, or if things have now changed completely. This could be a starting point for a whole series of inspiring e-mail discussions.

The Story. *China: An Iron Bar Can Be Ground into a Needle*, contributed by Nancy, year 6 pupil, Crookesmoor Junior School, Sheffield (Nancy comes from Shanghai, China; her parents are at Sheffield University).

Li Bai was one of the greatest poets of the Tang Dynasty in China. When he was a child he was very naughty and didn't work at all. One day he went to the river bank where he saw an old lady with white hair. She was grinding an iron stick. Li Bai was really surprised, so he asked the old lady, "What are you doing?" The old lady replied, "Making a needle." Li Bai was even more surprised. He said, "Making a needle? It is impossible!" The old lady said, "Nothing is impossible. An iron stick can turn into a needle if you work hard on it." Li Bai understood something from that. One should work hard at whatever you want to do and finally you will succeed. From that day on Li Bai studied very hard and made progress every day. At last he became a very famous poet.

Example 4: A Cloze Procedure

The story in Example 3 above, or any story, can be used as a cloze procedure text. Any word in the text can be substituted by "swobble", with accurate endings of course, so that correct grammatical structures and vocabulary can be reinforced. For example, the beginning of the story above, after substitutions might read as follows: "Li Bai was one of the greatest swobbles of the Tang Dynasty in China. When he was a child he was very swobble and didn't work hard at all. One day he went to the swobble where he saw an old lady with white hair. She was swobbling ..."

Example 5: Right or Wrong

The pupils are given statements concerning any of the texts and then have to decide whether these statements are right or wrong, according to the original story. This is a well-known technique.

Example 6: Posters and Collages

Since *Global Stories* come from all parts of the world and deal with typical ways of living, legends, etc., they offer potential to teach first-hand knowledge of a country. Posters and collages can enhance the ability of the pupils to discover and demonstrate the special quality of a story in terms of its cultural roots. For this activity groups can be organized in either of two ways, with groups receiving different stories or groups receiving the same story. Both cases stimulate a real discussion amongst the pupils, because there is an information gap between the different groups.

A. Groups Receiving Different Stories. Groups of three pupils each receive a different story from one country or from different countries. No group knows the story of the other group (taking for granted that they already know the basic vocabulary). The pupils draw the outline of "their country" on a large sheet of paper (or the back of a piece of wallpaper) and they choose photos from travel brochures, make their own little drawings or use parts of the texts and then stick them within the outline. In this way they can characterize the country and locate the story geographically.

After that, all the stories are read, the pupils find the stories which go with the posters and explain why they associate them in that way, e.g. "I think poster ... goes with this story because..."

B. Groups Receiving the Same Story. Each group is given the same story, makes a poster and explains why it has created the poster the way it did. (All this discussion should be taking place in the foreign language, of course.). The posters can also be exchanged amongst the groups. The groups describe the posters and ask the "makers" for explanations if they think anything is not clear.

Example 7: Making Audio Tapes

Since the stories are relatively simple in structure and easy to understand, most do not need detailed explanation. A simple introduction of the new vocabulary suffices in order to allow the pupils to work independently and invent their own radio plays. Although generally fairly simple, the stories do have different grades of difficulty, so teachers can differentiate between them and use them with pupils of different abilities. After that, the stories which go with the radio plays can be matched, which can be another reason for further discussions.

Example 8: Games

After dealing with several stories from the GLOBAL STORIES collection, pupils can make dice games concerning the countries represented. An outline map of the country is made and the country is filled in with pictures, photos and drawings. Then a games board is constructed on the map, where pupils can move according to the number on the dice. For each position, a card is made, referring to the story. The card has a question which must be answered correctly in order to move on. Every group can make a game like this. The games can be exchanged and played with dice and colored figures. So knowledge about the country can be reinforced and the construction of questions and commands and general reading ability can be practiced.

Summary

The possibilities for using e-mail texts are varied; the opportunities for creativity and fantasy are unlimited. It is necessary, however, to work hard at inspiring the creativity of both the (future) teachers and the pupils. Once the students have been inspired in this way, they are easily able to suggest many interesting and exciting ways to develop their language teaching.

If we want to change practice, we have to start with teacher education.

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Interactive Television: A New Delivery System for a Traditional Reading Course

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Two-way, interactive television has been part of the East Carolina University (ECU) educational agenda, through the Network for Interactive Learning of Eastern Carolina (NILEC), for more than three years. This system allows instructors and learners at ECU and selected towns in eastern North Carolina to see, hear and interact with each other. Using another interactive TV system, ECU also teaches courses to corporate sites in North Carolina and Maryland. Current offerings via distance learning from ECU include courses leading to a master's degree in industrial technology, an RN/BSN and master's degree in nursing, and a master of arts degree in education.

The use of interactive television offers several benefits. It eliminates the extensive travel time between the university and off-campus remote sites for both students and instructors. This technology can also reduce overall educational costs and provide access to resources located many miles away (Goldstein & Kamil, 1988). This is especially advantageous for the state's remote, rural areas.

East Carolina University is using various technologies to facilitate distance learning. Compressed video, which is a digital, two-way audio and two-way video system, is currently being used with the reading course that will be covered in this paper. Also available at ECU are full motion, 2-way interactive video, satellite transmission capabilities, and electronic mail coupled with Internet access.

The North Carolina Information Highway (NCIH) will, in the future, expand the current capability for ECU faculty to interact with additional sites by introducing more advanced telecommunications technologies. These additional sites will include other University of North Carolina (UNC) system institutions, community colleges, hospitals, high schools, government agencies, and other facilities in and outside of the state. By the end of 1995, approximately 100 sites will be connected via the NCIH.

Faculty have found teaching with technology to be personally and professionally satisfying. Many faculty develop statewide, regional and national reputations as a result of their greater access to more students via distance learning. Students have discovered that interactive video is an excellent way to learn and fulfill their educational goals.

Course Background

The graduate *Foundations of Reading* course (READ 6419) has traditionally served the region's teachers continuing their post-graduate education. This course provides basic information about the reading process - what it is, how a person learns to read, instructional strategies, methods, materials and approaches used in the teaching and assessment of reading. In the past it has been offered at off-campus hubs located 75 to 100 miles from campus as well as on-campus.

In the fall of 1994, this course was offered via interactive television for the first time. The class was "delivered" Monday evenings to learners in the Master of Arts in Education degree program from the ECU Center for Academic Communication in Jacksonville, North Carolina—a city 70 miles away. The remote classroom is located in the Learning Resources Center of Coastal Carolina Community College (CCCC). CCCC provided valuable assistance by hiring a site facilitator (funded through tuition), and furnished on-site technicians as well as library support services for the three-hour class.

Infrastructure

In order to offer an interactive TV course successfully, a basic infrastructure needs to be in place. The right policies, people, and equipment must be in place for a successful distance learning experience to occur. The more complete the infrastructure, the easier the task will be.

The best setting to introduce distance learning is one where the university has made a firm commitment to encourage its growth. This means it has allocated the appropriate funds to hire personnel to coordinate, direct, and produce courses. Experienced personnel must be in place to guide the program. Reliable and up-to-date equipment should be purchased and used. Since so much new ground is being broken with each step of distance learning, it is important for the equipment to work every time and to provide as much capability as is technically possible.

Faculty must be given the support which will allow them to pursue the development of a distance learning course. Because faculty exist within a rigid evaluation system which often does not look kindly on experimentation, specific incentives should be provided to reward faculty who use this new technology. Unless the university revises its method of evaluation, faculty will not be recognized in terms of promotion and finances for taking the time to develop these new courses. Released time or stipends are two ways to support faculty interested in developing interactive TV courses. (For this course, both were provided to the instructor.) Policies need to be in place that will encourage the development of distance learning rather than forcing those interested in this area to jump over the hurdles of an outdated system that offers no support—does not clear the way—for the successful development of that interest.

The proper policies should allow for the appropriate people to be put in place to make distance learning happen. A coordinator should be in charge to work with the technical staff, administration and faculty. Guidelines should be developed by the coordinator to assist faculty entering this arena for the first time. With each class, new insights are gleaned. The coordinator can relay what is learned from these experiences to faculty teaching the next distance learning course.

The technical staff plays a vital role in the success of distance learning. They should be knowledgeable in all facets of equipment use, and should have effective interpersonal skills as well. They will be working closely with faculty who are adjusting to a new teaching environment. Often faculty and technicians work collaboratively to solve problems in the studio. It helps if the technical staff are trained to be sensitive to faculty needs.

Instructional Design Guidelines

Distance learning settings require a careful assessment of program development and instructional design. Distance learning presents an opportunity for instructors to reconceptualize the teaching of their course. Following a careful analysis of class objectives, the instructor, with the guidance of the coordinator or instructional designer, must create new ways of meeting those objectives.

One of the dangers of interactive television is that the distance and the technology will become obstacles to learning. There are, however, many techniques that can be employed which will help overcome the "distance" in an interactive television course. The following techniques were used by the authors and are suggested as a means of planning a successful interactive television course.

1. **Instructors should become familiar with the camera and audio setup** in the studio before teaching the first class. You will realize that some of your previous methods will have to be changed. One example is that, in our case, where "big books" were used previously to demonstrate the Read Aloud technique, we had to switch to regular size books which were shown on the overhead camera.
2. **Discuss this new environment and way of learning with your students.** Make sure they receive proper instruction on how to use microphones, ask questions and make comments. Because of the visual limitations of the compressed video technology used in this course, we had to make sure that students speaking raised their hands so they could be distinguished. We also evaluated various telecommunication aspects of the class periodically to make sure things were going as well as they could. For example, some of the presentation package "slides" could not be seen in the back of the room at the remote site because the font was too small and there were too many lines on the slide. While we followed standard television graphic production guidelines, we discovered that compressed video needed stricter production parameters than full-motion video.
3. You must **remember to involve learners at both sites in each class.** There may be a tendency to forget one of the groups. This happened when we broadcast from the off-campus site. Because the monitor at the ECU site was behind the teacher, the students at ECU were out of the teachers' sight and out of mind. The monitor should have been facing the teacher so students at both locations would always be in sight.
4. Since interactive television can become impersonal, **take time to let students at the sites get to know each other.** Get information on each learner at the beginning of the course so that course content can be personalized somewhat to fit their needs. Be sure to call students by name and not by location. In addition, ask students to respond or make comments to each other during discussions so that the dialogue may be learner-to-learner as well as learner-to-teacher. Plan projects so your students can report via television to the class and thereby become more familiar with the medium. Each night our class began with a student group project.

5. **Realize that you are always on line and everyone can hear** what you are saying when you are near a microphone - even during class break.
6. **Always keep students apprised of what you expect** from them in terms of assignments and classroom participation. This is always important in any teaching situation, but it is even more important to do in such an unusual environment as distance learning.
7. **Videotape your classes and evaluate them** for ways to improve. This is one of the hardest things to do, but most people do become accustomed to seeing themselves on television. (If you want a real laugh, put the tape on fast forward and watch yourself go!) Your course coordinator or instructional designer can sit in on a few classes at the remote site and provide you with valuable feedback as well. You may also ask your students periodically how things are going and what you and the production crew can do to facilitate their learning.
8. **If time allows, visit each remote site** at least once. Become familiar with the classroom layout and constraints so you will understand the environment of your learners. The physical layout of the ECU off-campus site allows for only a small variation of movement or groupings. Our plans had to be adjusted accordingly. Additionally, visiting the remote site allows you and the students to get to know each other better. One of the greatest joys of teaching is the interaction with people. Recently one of the off-campus students attended class on-campus. That personal contact made the class much more enjoyable for both student and teacher.
9. **Get to know your site facilitator.** This person is very important to the success of your class, and is actually your "eyes and ears" at the remote site. Call on the facilitator whenever you want to make sure that your learners are "on track." Because it was difficult to know when the students were finishing their small group discussions, our site facilitator had to cue us when he thought groups were winding down on group assignments, so we would know when to return to the whole class discussion.
10. **Sometimes there will be technical difficulties,** but don't feel doomed if they occur. Be assertive about mentioning problems to the technicians. Remember your first duty is to your students and they may not speak up if difficulties occur. If problems do arise, stay calm and quietly explain what is happening to your viewers and what is being done to alleviate the situation. It helps to learn what the technology can and cannot do. For example, once we discovered the slides being shown on the screen were not numbered as they were in the software presentation package, we had to communicate with the technician about them in a different way.
11. **Arrange for video office hours,** if feasible, or times when you can be reached by telephone, fax or e-mail. Students will feel less isolated if you make a point of being readily available for consultation.
12. **Ask questions on a regular basis.** Be certain students understand procedural matters. Ask for feedback on how well they are following new concepts and material.
13. **Above all, be prepared!** There is nothing more annoying to students and production personnel than an instructor who seems distracted and appears to be wasting everyone's time. This type of problem seems to be magnified when on television. Everything for this type of course must be prepared well in advance. You will need additional time to mail materials to your students. You simply cannot distribute them the night of the class as you normally do.

Interaction is often the key to a successful learning experience for distant students. Although the current literature on distance learning is divided regarding what types of interaction are best, there is no doubt that most learners perform better when they have opportunities to interact with the instructor, each other and, of course, the course content (Klivans, 1994). The old lecture mode is a surefire method of putting people to sleep. Remember that you are fighting years of passive television viewing.

Many instructors already employ interactive techniques in place of or to supplement lectures. In order to avoid the "talking head" syndrome, it is important to plan a variety of activities within the framework of each session. The following ideas were used and are offered as suggestions for you to increase the interaction in your group:

1. Use **advance organizers** at the beginning of every class so students know what is expected of them. At the end of each class, summarize the session and inform learners what they'll see and hear during the next session. We show the class objectives via slides at the beginning of each session. When the students return from the mid-class break, they are met with an interesting picture or joke on the overhead. This has helped relax us all and primes us for that last hour of concentration even though it is late at night.
2. **Avoid filling up every minute with lecture and content.** If possible, allow time for group discussion and activities. We eventually used far fewer of the planned slides and lectures and instead turned to more group work, as well as discussion and interaction whenever possible.
3. The following is a partial list of some of the methods **incorporated into** this **distance learning course: lecture, mini-lecture, demonstrations, analyses of content followed by discussion, questioning strategies, group projects, peer teaching, brainstorming, case studies, and trigger video** (play a short video which triggers discussion). Your instructional designer can explain these in greater detail, help you use these methods in your course, and suggest even more strategies. It is a good idea to build one of these "change elements" into the class every twenty minutes or so to maintain attention and add variety.

4. **Don't forget to incorporate a break every hour!** This is especially important for courses taught via television, where visual fatigue can easily set in, especially at night.

Many of these suggestions incorporate common sense and good teaching principles. There is nothing exotic about any of these ideas; in fact, you've probably already used most of them in your classes. Many instructors comment on how teaching at a distance helps enhance their face-to-face instruction in a traditional classroom. You may find this to be true as well.

Conclusion

With the onset of the information highway, more universities will be offering courses, seminars, and workshops via distance learning. In the future ECU's audience will no longer be limited to the local region, but may span the state or the country. ECU views this semester's interactive television broadcast of READ 6419 as a pilot which will allow the university to learn how to adapt traditional instructional design to the requirements of distance learning.

A comprehensive evaluation plan involving students, faculty and support staff will help ensure a successful experience. At every other class session, a few minutes were spent evaluating the delivery system to make needed changes. The coordinator observed several classes early in the semester to gauge how well the course was being received and the coordinator and the teacher regularly viewed class videotapes looking for ways to improve the delivery. At the end of the semester, an evaluation instrument was completed by students assessing the content of the course as well as the delivery system. Informal sessions between the coordinator, crew and instructor also provided feedback to the various members of the team and contributed to the improvement of the setup. This continuous communication became necessary as we were all learning our roles in this new system.

As this paper goes to press, the course is still in progress, so final evaluations have not been collected. However, the overall impression from students, faculty and staff to date is that this course is being well received. Students are very happy about not having to drive ninety minutes each way for the class. From their comments we can conclude that they have adjusted to the idiosyncrasies of the system. Some students appear more at ease with this method of communication than others and we are encouraging fuller participation by all. It took about six class sessions in front of the camera for the instructor to feel really comfortable with the experience. Up until that point, broadcast days were a bit anxiety-producing. With a half semester completed, a relaxed and confident instructor is meeting these distant learners. The effective communication between the members of our team also helped build her level of confidence.

Since this course is considered a prototype, the people involved are deeply interested in obtaining qualitative evaluations from all concerned - students, faculty, and staff. In addition to the methods of evaluation mentioned above, the staff will sit down for a debriefing session at the end of the semester. Such feedback will be vital in designing and coordinating future courses delivered at a distance.

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Planning and Creating Interactive, Multimedia Lessons for Literature-Based Reading Programs

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Reading instruction over the past ten years has become increasingly literature-based with many teachers creating literacy lessons based on the needs of their own students (Cooper, 1994). With the focus on children's literature as a primary source for reading instruction, what are some technology-based resources that complement literature-based reading instruction and how can teachers develop literature-based lesson plans that incorporate these resources in an efficient, effective manner? This paper will address both of these questions.

Software in a Literature-based Reading Program: Three Vital *Interactive* Resources

The best use of technology for a literature-based reading program is through software that promotes interactivity and builds on the premise that reading is a constructivist activity. Constructivism can be best be thought of as the belief that comprehension is a process by which the reader constructs or assigns meaning by interacting with the text (Anderson & Pearson, 1984). The first interactive resource in a literature-based reading program should be an easy-to-use multimedia authoring program, such as *HyperStudio*, that has a low learning curve for both teachers and students and that allows the developer of the literacy plan (the "construction" worker) to build connections within the specific literature or construct bridges to information outside the literature through the use of interactive buttons. These buttons, for example, could link attributes of the major characters within the story to one another or to previously studied characters in other stories. A second source, interactive telecommunications, can support a literature-based reading program through software packages that contain an interactive graphical interface—such as *MOSAIC* (or in its newer version, *Netscape*)—providing electronic information that is textual as well as video, graphics, and audio-based. Multimedia CD-ROM programs are a third interactive source. These programs can provide reference-related information, such as electronic encyclopedias, that include video, audio, and text.

The best use of technology in a literature-based reading program that is built on a constructivist philosophy is, therefore, to support the interactive nature of the reading process. The three recommended interactive software resources mentioned above (interactive authoring software, graphical interface telecommunications software, and interactive CD-ROM software) do this.

Basic Prerequisites for Developing Interactive Plans

Before, During, and After Reading. A well developed lesson plan that incorporates interactive multimedia should focus on literacy events that occur before, during, and after reading instruction. Before reading instruction with a literature source begins, the teacher should determine how technology can be used to present information. For example, the teacher can develop a slide show using *ClarisWorks* and share it with all the students using a video-projection device. Teachers could also develop interactive demonstrations for the entire class that incorporate CD-

ROM material and/or laser discs. During this stage of the presentation of the book, students are indirectly involved in interactive technology through listening, reading, and discussing the content in a prereading format.

During reading, the teacher and students integrate the new information across the curriculum in an interactive format. The teacher involves the students directly in the technology through projects that incorporate all four areas of the language arts: reading, writing, listening, and speaking. An authoring program can be used which includes color, graphics, animation, sound, and laser video access. Students can also be grouped cooperatively to focus on problem-solving and information retrieval. The knowledge obtained through this process can be shared with peers within the classroom and around the world. The role of the teacher during the reading stage is to learn how to use the technology with the students, develop themes for the interactive projects that are connected to the reading, design problems that connect to the reading, search the Internet and/or CD-ROM programs to determine possible sources, and finally supervise and assist students while they produce their own multimedia projects within an integrated format.

After reading, the teacher and students submit materials for the electronic portfolio that will provide an interactive record of the students' work. This form of preservation of information relates directly to the instruction and is, therefore, more authentic and relevant. The portfolio could include a reading log, assessments related to the reading, such as a Retelling Profile, writing samples, and any other artifacts that support the reading.

A Literature-Based, Interactive Multimedia Lesson

Included below is an example of a literature-based, multimedia lesson for beginning readers in late first or second grade, based on the book *Henry and Mudge in Puddle Trouble* by Cynthia Rylant. The lesson activities are divided into three sections: before reading; during reading; and after reading. A chart that summarizes how technology is incorporated across the curriculum can be found in Table 1.

Before Reading: Presenting Information using Technology. The teacher can display a scanned copy of the cover of the book on an LCD panel. Discussion of who the characters are and why they are in the water could follow. The words /HENRY/ and /MUDGE/ from the cover need to be highlighted as the teacher explains they are typed in all capital letters to make them stand out on the cover. In the text of the book, the words appear as /Henry/ and /Mudge/, so the teacher needs to show the children these words by writing in or typing in the words with the visual image as it "looks" in the text. Students can be encouraged to share any experiences they have had with a dog or with playing in water after rainy days. Interest in the children's silent reading of the second story in the book, *Puddle Trouble*, may be heightened if the teacher asks, *Why would Henry and Mudge be smiling if they were in puddle trouble? The story may give us some hints*. Interactive buttons from the scanned page can lead to a card that contains "character" attributes for Henry and Mudge.

***During Reading*: Using Technology to Incorporate Reading Strategies while Integrating the Curriculum.** After silently reading the story, *Puddle Trouble*, students could be grouped according to need or interest to develop responses to the following situations.

Science/Math/Language Arts (Summary)/Social Studies. The story *Puddle Trouble* happens in April after many rainy days. The teacher can use these questions with students: *Have you ever heard the saying, April showers bring May flowers? What does that mean? Does it mean the same thing to people who live in other places?*

Have the students send a letter through e-mail to ask what people think the saying means. Students can ask what the weather is like in their area in April. What do they do when it is rainy? Do they go outside and play in puddles like Henry and Mudge? Do they stay inside and play games? On the word processor students may summarize the responses received. After getting responses, students could put a stick pin in a mounted world map to see where people live. The encyclopedia on CD-ROM can be used to learn more about that area. Does the encyclopedia give any information on rainfall in April for that place? What kinds of things look like fun things to do if you ever visit that place?

Language Arts/Reading (structural/morphemic analysis). The teacher might explain that the author, Cynthia Rylant, uses words to let the reader know the story already happened. The teacher might say that Ms. Rylant adds *ed* on some words to help us figure this out. The teacher may then ask the following questions:

Look on page 24 and find words that end with /ed/; (listened, looked, wagged, wiped). Can you find the root word or the base word for each of those words? What do you notice about how these words are spelled? They show three ways to add /ed/. Can you figure this out? On the word processor, type in the following root words and see if you can guess how to add /ed /to them. Use the spellcheck to see if you are right. Can you find these words in the story?

step	walk	rain	surprise	splash
bore	love	call	smile	

Science/Math. The teacher may help students use science and math with this directive, *Contact a nearby TV station, either with a phone call or a letter you type on the word processor, and ask the weather reporter to send the average monthly rainfall for each month over the last two years.* Students can create a chart showing rainfall using a grid created with a paint program.

(Teacher-directed) Music. Music is often used to augment text by creating emotive feelings in the reader. *Puddle Trouble* addresses the rainy season and the fun created through mud squishing between the toes. Using a music CD of Vivaldi's *Four Seasons*, create an interactive button to access the lilting melody of spring. Ask the students to create a jot list of feelings that they associate with both the music and spring. They can describe the quick pace of the music that symbolizes increased activity and the dynamic growth and rebirth inherent in spring.

(Teacher-directed) Art. Have students take a virtual tour through the Metropolitan Museum of Modern Art on CD-ROM. The purpose of their visit will be to explore paintings related to spring. They will complete this activity in cooperative groups and will annotate the paintings, answering the following questions: *What about this painting is attractive to me? What would Henry like about this painting?*

***After Reading*: Collecting Student Artifacts for Preserving Information in Electronic Portfolios**. The students will enter (with the assistance of the teacher, if needed) the following information that demonstrates understanding of several of the activities covered in this electronic-based literature unit.

Vocabulary Map. The student will enter into the electronic portfolio three vocabulary maps for words that are structurally similar (e.g. have /ed/ endings). This will help determine the degree to which the student understands how the structural ending /ed/ actually changes the meaning of the word.

Oral Reading Sample. The student will enter a two-sentence oral reading sample to determine fluency and expression. This sample will be entered from the written description of the paintings that related to *spring* and miscues noted.

Conclusion

When planning reading instruction using literature, it is important to consider the role of interactive technology. When instruction is planned that demonstrates the constructive nature of the reading process, both students and teachers will benefit. This paper has presented a number of ways this benefit can be obtained.

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Note: HyperStudio software is available through Roger Wagner Publishing.

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Table 1. Technology and Literature Across the Curriculum

Henry and Mudge in Puddle Trouble by Cynthia Rylant

Curriculum areas	**Reading Strategy**	**Activity/Purpose**	**Technology needed**
Science/Math/ Social Studies/ Language arts (summarize)	Observing	Note weather pattern	E-mail
	summarizing	Collect variety and identify locations of places responses come from in USA Summarize results	CD-ROM encyclopedia Paint program Word processing
	Charting	Chart weather patterns	
Language arts/ Reading (structural analysis)	Vocabulary mapping	Addition of /ed/ morpheme to root words with and without spelling changes to understand concept of "past"	Word processing-spellcheck
Music	Listening	Enjoy quality music and express feelings it gives	CD-Vivaldi's *Four Seasons*
Art	Observing/ Noting details	Explore paintings related to spring Observe a variety of artistic representations	CD-ROM Metropolitan Museum of Modern Art

Using CD-ROMs to Develop Automaticity and Fluency in Reading

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The technology of CD-ROMs is currently being used to teach content in science and social studies, to provide reference resources, and to supply sources for graphics and sounds. It is not surprising that CD-ROMs have also found their way into reading instruction. Since the appearance of the Discis Books series in the 1990s, books for various levels have appeared on CD-ROM. These books are certainly entertaining and delightful with the inclusion of sound, graphics, and, on some, animation. Children and adults alike enjoy these programs; the question is can they be used in reading instruction or are they merely expensive electronic books that provide no additional value beyond their novelty and entertainment. If they can be useful in instruction, then it is necessary to include methodology in their use in reading methods courses.

Review of the Literature

The mature reader recognizes most words instantly, stopping the flow of reading only to analyze unfamiliar words. This process is called automaticity and/or fluency. There is a preponderance of empirical and clinical evidence that supports the relationship of automaticity and good overall reading ability (Allington, 1983; Lipson & Wixson, 1991; Vacca & Vacca, 1991). There have been various approaches used in the classroom and clinic which have successfully developed automaticity/fluency in readers. The most widely used techniques have used repeated readings of the same text. The steps suggested by Samuels (1979) when using repeated readings are (1) students choose short selections (50 to 200 words) from stories that are difficult enough that they are not able to read them fluently; (2) students read the passage over several times silently or orally until they are able to read it fluently; and (3) students tape-record their first oral rendition as well as their oral rendition after practice so they can hear and self-evaluate the difference in fluency.

Another technique that has received wide acceptance among reading educators has been Heckelman's (1969) unison reading, popularly known as "neurological impress." A good oral reader (teacher) reads a line of print, asking the student to read in unison, as the teacher slides a finger along the line of words being spoken.

Chomsky (1978) adds the tape-recorded story to the repeated reading technique. She recommends that (1) students listen to a tape-recorded story, following along with the text; (2) students read and listen repeatedly to the same story until they can fluently read the story; (3) students choose the book or a portion of the book and they continue to listen and read until they are able to read it fluently by themselves; and (4) students should be helped to choose a book that is too hard to read, but not so hard that it is out of the range for repeated readings.

There are many suggested modifications of the above techniques in the professional literature. Common threads which run through the more successful ones are (1) the use of a fluent reader as a guide or model; (2) options to "mimic" or echo the mature reader's expression and intonation patterns; (3) repeated readings of the same passage; (4) student self-monitoring of increased fluency;

and (5) student choice of passages to re-read. Also common to most approaches is a high investment of teacher time. Given large class sizes, a wide range of abilities and skills within classes, and limited resources, children with poor fluency often are left without remediation.

Poole (1995) indicates that "the jury is still out on the effectiveness of using computers to help children learn to read" (p. 19) but points out that the "use of CD-ROM technology to bring a book to life with text, full color illustration, and sound, need to be studied" (p. 19). He cites Computer Curriculum Corporation's claim that average student reading scores were raised by 57% over a two-year period in a North Carolina elementary school that used its CD-ROM materials.

Miller, Blackstock, and Miller (1994) investigated the use of CD-ROM books versus hard-covered books in the reading behavior of young children. The measure used for comparing improvement in reading was "search for meaning" miscues. The investigation found gains for those students using CD-ROM books were greater than what would be expected from repeated readings. The authors attributed these gains to the "on-demand mediation features available in CD-ROM books" (p. 187).

One of the functions which can be provided by CD-ROM books is that of speech. All CD-ROM books surveyed provided the reading of the text. Most allowed the user to click on a word in the text and hear the pronunciation of the word (a minimum feature). Wise, Olson, Anstett, Andrews, Terjak, Schneider, Kostuch, and Krito (as cited in Anderson-Inman, 1990-1991) found that "providing computerized speech feedback to students with reading difficulties is an effective way to improve their reading performance" (p. 27).

On close examination, many of the books on CD-ROMs appear to contain the critical features of proven automaticity/fluency techniques currently in use. More specifically, the following options are often possible to achieve: (1) an adult model reading fluently with expression; (2) self-monitoring of accuracy through "click-on" word and sentence options; (3) unison reading, with highlighted passages and words to track approximate voice placement; and (4) "echo" and repeated readings, with student choice of high interest passages. In addition, use of the CD-ROM books would appear to require little teacher investment of time, as the computer with CD-ROM is able to read the text with expression, pronounce words repeatedly on request, and allow student independence and privacy as unison reading with a mature reader is achieved.

The Study

Faculty in reading and computer education collaborated in an attempt to determine if books by the same author or books with similar themes, characters, and the same readability level as determined by Gamco's (1990) *Readability Analysis*. Children were asked to read from both while being videotaped. The nine children chosen for the project were those who needed to improve their automaticity/fluency and could benefit from using a repeated readings technique. An additional consideration was the child's instructional level since it was necessary to work within the limited range of available CD-ROM books. The instructional level of the children was determined by the Silvaroli (1994) *Classroom Reading Inventory* or Ekwall and Shanker's (1993) *Reading Inventory*. The children ranged in age from seven to ten and the sessions were held once a week for eight weeks. Two children had two sessions using the CD-ROM and two using the paperback book. One child had four sessions of each and the rest had three sessions of each.

Although in the beginning, the main concern was centered on the behavior of the children, it soon became apparent that perhaps an equally great problem was the way in which the different teachers approached the use of the computers. Most of nine teachers in this study had either not taken any computer courses or had only one "introduction to computers" course. This meant that their knowledge of computer use limited the way in which the child used the computer even though they were given written instructions on exactly what to do. In addition, there was a graduate assistant knowledgeable about computers available to them during their time with their child in the computer laboratory.

Procedure

Prior to going to the computer laboratory, the teachers met with the college professor who explained the task. Each teacher was given a handout on working with the paperback book (Munsch, 1984a, 1984b, 1990, 1991c), the CD-ROM book (McKend, 1991; Munsch, 1991a, 1991b, 1991d), and preassessment and post assessment sheets to be filled out at the proper times. A schedule was determined that allowed 30 minutes for each student to read the paperback book or work on the computer. The teachers were asked to study the materials carefully and were given an opportunity to ask questions. The teachers were chosen at random according to the children they had been assigned who needed work on fluency and were at the necessary instructional levels. The researchers chose passages of 50 to 100 words in the paperback books and on the CD-ROM, and the children were asked to choose their practice passages out of the pre-selected passages.

Next the teachers went to the computer laboratory and the graduate assistant there explained the setup with the video cameras and then instructed them on how to use the CD-ROM discs and the Discis Books. The teachers got acquainted with the materials and returned to the classroom to prepare their child for the sessions with either the paperback book or the CD-ROM as assigned.

At the appointed time, two groups of two children went into different rooms. Two went to the computer room and two went to another room to read their paperback books. The written procedures explained what was to be done in each situation. After the first 30 minute group finished, the second group of four children, two to each room, went to their CD-ROM or paperback sessions. The process was repeated for a total of eight weeks—two to four weeks using the CD-ROM and two to four weeks using the paperback book. The college professor checked with the teachers before and after each session to see how much progress was being made. After the first two sessions, it was determined that 30-minute sessions on both the computer and paperback books were too long. The children were inattentive and tended to waste time rather than concentrate on the task. Therefore, the time was reduced to 15-minute sessions which appeared to be more appropriate for both the children and the teachers. Those that started on the paperback book appeared to be happier about moving to the computer than those who started on the computer and then moved to the paperback book.

Results

Each preassessment and post assessment was timed. On the paperback readings, one child took one minute more from the preassessment to the post assessment but read with better expression, while another took 5 seconds more but read without error and with improved expression. The remaining children all read more fluently and with better expression and the time was either the same or slightly less. On the CD-ROM, all read more fluently with better expression and the time was either the same or slightly less. The difference here may be due to the way in which the teacher read the paperback story. Some of the teachers read with greater expression than others while the oral reading by computer provided a consistent model of mature reading.

The reactions of the children to the reading of the paperback book as noted in the videotape included their listening intently while looking at the pictures and occasionally glancing at the words as the teacher read the story. They gave visual clues to the fact they were listening by raising eyebrows, wrinkling the nose, or waving their hands. On the CD-ROM, the video was focused on the computer screen and visual reactions of the children were not as obvious. Occasionally they pointed to the screen or made a comment about what was read. They tended to exhibit restlessness as they participated in the repeated readings. They had a great deal of difficulty directing the mouse to find particular words and to turn pages. Perhaps this is why only two of the children clicked on words or clicked on reading by sentences. This could have also been attributed to the teacher's lack of encouragement which in turn may have stemmed from their lack of computer knowledge and unfamiliarity with the many options afforded by the CD-ROM. Two of the five teachers checked the computer recall to get the words that the children clicked on. The rest did not need to do so because their children did not click on any words even though they did not know them. In one instance the teacher told the student the word instead of having the child click on it.

Teachers' comments on evaluations of their weekly lesson plans tended to be similar for both CD-ROM and the paperback books: (1) Student began to read in phrases instead of word by word; (2) Student remembered words learned from last week; (3) Student is reading more fluently; (4) Student did not read word by word and read with proper stress and proper pitch; and (5) Student was worried about saying the next word wrong. Comments related to the use of the CD-ROM books included: (1) Student using CD-ROM memorized the passage and said he "knew it by heart"; (2) Student enjoyed working on the computer but it was a "let down" to read the paperback after being on the computer; and (3) Student pauses more with the computer than the book.

Upon completion of the sessions, a survey was distributed to the teachers and students. The data from these surveys are currently being compiled and analyzed.

Discussion and Recommendations

Essentially there does not appear to be any significant differences in using either the CD-ROM or the paperback books for repeated readings. The big difference will be in the freeing-up of teacher time if teachers can get comfortable with the proper use of the computer and find the right software for their students.

As the study progressed it became obvious to the researchers who viewed the tapes that the teachers really were not prepared to do this kind of study using computers and that, if this is true in a controlled environment, then teachers in the field must be having a difficult time deciding what to use and how to use it. If computers are to be used to improve children's learning and to free up some of the teacher's time, then something must be done to provide the correct assistance to teachers. Some considerations might be:

1. No software should be purchased without a commitment to inservice training.
2. A single software program should not be considered appropriate for all classes.
3. Teacher preference and experience should be ascertained. Teacher experiences with computers affect how computers are used in the classroom and the software that is to be used.
4. Children need teacher feedback about what they have done on the computer. This means the teacher needs knowledge about the software in order to encourage the children's correct usage.
5. Without proper training, teachers tend to use computers as if they were books and do not employ the unique features of the computers.
6. Certain procedures such as repeated readings can be done by a child without teacher assistance only after the child has had an opportunity to explore what the computer can do and knows exactly what steps to follow. Children need playtime on the computer using other CD-ROM books on their independent reading level to get used to the mouse and clicking on words.
7. Teacher and student attitudes toward computers affect how well the computer will be used.
8. When it comes to using computers, nothing should be taken for granted. What to do when things go wrong needs to be a part of the training for both teachers and children.

From the preliminary results of this study, it appears that CD-ROM books can achieve similar results in developing automaticity/fluency as can repeated readings from paperback books. The advantage of the CD-ROM books is, after proper training, the investment of teacher time is minimal compared to the original repeated readings technique. Therefore, it seems that books on CD-ROM might have a valuable place in classrooms and in clinical reading improvement programs.

A copy of the full paper including the written procedures used in training the teachers, the surveys given to teachers and children, and the analysis of the data will be available at SITE 95.

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MATHEMATICS

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The Mathematics Education Reform Movement to improve the teaching and learning of mathematics has been guided by the National Council of Teachers of Mathematics (NCTM) *Curriculum and Evaluation Standards for School Mathematics* (1989) and *Professional Standards for Teaching Mathematics* (1991). These standards were established to create (a) a coherent vision of what it means to be mathematically literate in a world that relies on technology and (b) a set of standards to guide the revision of curriculum, instruction, and assessment based on the current knowledge that we now have about how children learn. The papers presented in this section provide rich responses teaming with technology experiences to NCTM's call for reform.

Poole and Simonson use the Internet to provide their preservice elementary teachers with some "real" experiences of what happens as elementary students solve non-routine math problems. Each of their preservice teachers was linked with a small group of elementary students. The children were asked to solve each problem posed by their Internet mentor and then to share with that teacher their solutions and problem solving strategies. The main focus of this activity was to help the preservice teachers to develop skills in diagnosing errors and in redirecting student thinking.

Cooper has found that one of the most significant technological resources for her undergraduate elementary mathematics teacher education courses is the use of student tutorials (created using the software *Toolbook*). These tutorials are designed as extensions of concepts discussed in class sessions. They provide students with reflective opportunities to explore strategies in remediation and diagnosis, assess student knowledge, select appropriate manipulatives for worthwhile mathematical tasks, and consider alternative forms of assessment.

Assessment of student learning when implementing computer technology in mathematics classrooms is the focus of the Pokay and Tayeh study. In an informal geometry course which used the *Geometer's Sketchpad*, preservice teachers focused on mathematics as a process by inventing procedures, making generalizations, and reasoning mathematically. Each of their computer assignments was designed with alternative assessments that focused on several key areas: (a) evaluation of student knowledge of the computer, (b) learning of the geometry program, (c) knowledge of geometry concepts, (d) interactions with one another and the technology. Assessments were designed to help students reflect on their own learning as well as to provide information for the instructor about this learning.

Atkins describes the PERSPECTIVES project which is endeavoring to create a K-3 mathematical learning vignette database for use in teacher enhancement and teacher preparation programs. The vignettes provide the user with glimpses into students' mathematical constructions. The professional development program is designed to provide participants with opportunities to engage in mathematical activity, view children engaged in a mathematical activity previously experienced by the participant, and analyze the conceptual understandings of the children by "listening in" on their mathematical conversations.

Connell summarizes how seventh grade pre-algebra students used a five phase approach to solving problems which allowed students to construct their own understandings in mathematics via physical materials and a computer authoring system (ToolBook). The roles of the manipulatives and computer described in this model differ from traditional approaches. Rather than using manipulatives to demonstrate procedures or rules, problems are posed which require active student involvement with physical materials to model mathematical situations. The computer is used in the last stage when the students are ready to construct arithmetic generalizations and problem solving processes through scripting their developed understandings on an IBM computer using ToolBook.

The Skymath Project, as described by Lynds and Gordon, is preparing a middle school mathematics module incorporating current environmental and real-time weather data. The technology component will make use of the Internet and the "Blue Skies" program at the University of Michigan, an innovative and successful program that provides weather and other environmental data in graphical, textual, and numerical modes for K-12 classrooms. The goals of the pilot project are (a) to create purposeful tasks to teach important mathematics; (b) to elicit higher-level thinking, reflection, and communication; (c) to motivate students by incorporating real data and authentic tasks; and (d) to bring to light the power of mathematics through a combination of math-focused, structured experiences combined with more open-ended exploratory experiences.

DeBlase and Wagner share their experiences which involved using interactive mathematics texts with ninth grade students in a mathematics, science, and computer science magnet school. Their goal was to engage students into becoming more active in their learning process. They discovered that student use of interactive texts to explore mathematical ideas engaged students by eliminating the boring labor necessitated by hand computations, allowed students to gain ownership of concepts and relationships, encouraged teamwork, stimulated creativity, helped students to extend and refine knowledge, and required writing.

Hudspeth and Maxey investigated how a relatively new telecommunication tool, the electronic bulletin board system (BBS), might enhance the education of student teachers. They used their BBS to provide a wide variety of functions for a group of secondary mathematics student teachers, i.e., electronic mail, conferencing capabilities, computer files with a wide array of teaching resources. They found that the student teachers used the BBS to discuss critical issues, to share ideas, to improve lesson planning, to question instructional approaches, and to provide support for one another. Through the collaborative efforts of these students teachers, growth in teaching competencies were recognized and collegial alliances were fostered.

Through a secondary mathematics teacher education course, Peelle focuses on how to utilize and integrate computing (rather than computers) in teaching mathematics. He introduces a computer notation (called J) in his course to help make underlying mathematical notions clear. He believes that the experience of learning a new language allows teachers to clarify their own mathematical understandings and thus improve their instruction.

Training strategies for guiding teachers to experiment with information technology (IT) is the subject of the paper by Forcheri and Molfino. They provide guidelines for developing training courses which teach teachers how to analyze educational situations in order to determine which kinds of technological tools could best be used to improve the learning process. The teachers in their courses designed instructional units which integrated technology.

Finally, Harnisch describes a computer program for use in assessment which provide a series of reporting options to determine precisely which students are having difficulties with which concepts and determine how well the testing instrument itself is functioning. Thus armed, teachers at all levels can fine tune their assessment, curriculum, and questioning.

The articles in this section provide us with a view of how technology is beginning to be used in mathematics education courses and in mathematics classrooms. They provide new insights into how technology can assist in the training of preservice and inservice mathematics teachers and how the technology can enhance K-12 classroom experiences. The ideas they contain provide fuel for future research in mathematics education.

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Making Mathematics Real for Preservice Teachers: Using the Internet

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In the last decade, the National Council of Teachers of Mathematics (NCTM) has emphasized the need for children to learn mathematical problem solving skills as a part of their education. Several plans, including the NCTM Curriculum and Evaluation Standards (NCTM, 1989), have been developed to help stress the importance of problem solving. As a part of the NCTM professional standards, educators are urged to give greater attention to problem solving instruction (NCTM, 1991). In order for teachers to feel comfortable helping students in mathematical problem solving, they need to develop their own skills to address these needs.

The NCTM (1991) has also emphasized the importance of using technology in the mathematics curriculum to help students develop problem solving and other math skills. Computer use in and of itself does not guarantee learning, however. If computers are to become meaningful tools in the mathematics curriculum, teachers need to be trained in techniques of using technology most effectively (Branscum, 1992).

In order to prepare future teachers to teach problem solving skills, their own fears and anxieties must be addressed. Elementary education majors have more math anxiety than students of other majors (Kelly and Tomhave, 1985). Students in a math anxiety workshop were the only group to have more math anxiety than female elementary education majors in this same study. If undergraduate education programs do not address the issue of mathematics anxiety, then future elementary school teachers may be hindering the growth of problem solving skills among elementary students instead of helping it.

Use of the Internet in the mathematics teaching methods curriculum has the potential to be a very powerful technology tool for undergraduate education majors. Implementing critical thinking strategies and collaborative problem solving methods to work with peers around the world in finding new solutions to the multiple social, political, economic, and ecological problems is one of the visions of computer-mediated communications held by Kurshan (1991). However, the use of this technology in the preservice curriculum has not been thoroughly investigated.

Technology and Preservice Teachers

For technology to be a significant learning tool, it should be used as more than merely an add-on to the curriculum. Internet use may be an effective way of promoting this integration. It is one of the fastest growing areas of computer technology today, yet little research has been done to find out how it can be used in instructional settings to promote learning (D'Souza, 1992). In fact, D'Souza (1991) claims that although the business world has adopted electronic mail (one of the applications of the Internet), its reception in the field of education has been mediocre. Despite this limited reception, the educators who are using the Internet have recognized many educational benefits.

If the use of technology in the schools is a goal in education, then teachers must be trained in effective methods for incorporating the use of technology into their curriculum. Most new teachers, even those who have had formal experiences in educational technology during their preservice training, report that they are not comfortable with the technologies (U.S. Congress, Office of Technology Assessment, 1988). Comfort is only one aspect of technology integration. Teachers also must believe in the role of teacher as facilitator rather than knowledge-giver (Byrum & Cashman, 1993). Teachers as facilitators can use the technology in ways that help learning which differ significantly from the drill and practice and tutorial software that is most commonly used.

In a study assessing the perceptions of 436 preservice teachers regarding technology, it was found that there was little exposure to the computer and the role of the computer outside of college technology courses (Byrum & Cashman, 1993). This technological isolation reduced the opportunities of these future teachers to develop a concept of curriculum integration. Isolating technology into one technology course reduces preservice teachers' perceptions of how educational technology might be connected with all educational fields. Although they may have mastered "technical" content about hardware and software, preservice teachers in these situations do not see how computers fit into subject matter content (Diem, 1989). Davis (1993) says that there is need for considerable curriculum development related to information technology in preservice teacher education because of the intensity of the courses, the level of student work, and the range of subjects studied. Students need to see more than just a "show and tell" approach to the integration of technology in order for them to feel comfortable using it in their own classrooms later on.

The Internet in the K-12 Curriculum

The use of the Internet in preservice education programs offers several benefits to undergraduate training programs. Although it is ideal, sometimes it is not practical to provide direct experiences with elementary students. Use of the Internet can make it possible to provide at least a limited experience of what happens as elementary students learn. Preservice teachers can be linked electronically to elementary students in learning situations. Allen (1993) noted the importance of this training in her study that linked fifth grade students with undergraduate secondary English education majors via electronic mail. She wrote, "In a way similar to the way beginning writers flourish when they have an audience to write to, preservice teachers may be given an opportunity to develop their skills at diagnosing potential student problems when they are provided the audience through the use of computer-mediated communication" (p. 9). The technology is used to foster an intermediate level of experience, where preservice teachers can apply what they have learned in a practical manner (Gorrell & Downing, 1989).

The Telecommunications Activity

Preservice elementary education majors at Iowa State University learned about the mathematical problem solving capabilities of elementary students from Alaska, New Mexico, Pennsylvania, and Wisconsin in an activity that linked them with elementary student groups. To help try to decrease math anxiety of the elementary education majors, as well as to increase their own mathematical problem solving skills, two non-routine math problems were presented in each class session. The math problems presented in class were problems that elementary students in grades four through six could realistically solve. Students were given time in class to attempt to solve the problems, using calculators and collaboration with others.

After the students worked with the problems, volunteers from the class were asked to explain their solutions. Multiple strategies were discussed for solving each problem. The purpose was to give students confidence in their own methods and to encourage alternative ways of approaching problems. Students also discussed how the problem could be misinterpreted by elementary students, and how problems could be better clarified for the elementary students.

The preservice teachers then applied their knowledge about the problems by sending one of the problems per week via electronic mail to their two elementary student groups. The college students could choose from among any of the problems solved in class, based on the abilities of their elementary groups, and their own personal understanding of and confidence with the problems. Along with the math problems, the preservice teachers shared other information about themselves, Iowa, and general events.

The elementary students received and worked the problems in groups of three to five students. When the elementary students found solutions, they responded to their "mentors" electronically. The elementary groups were required not only to send their answer, but also to explain how they arrived at their answer. This was sometimes a difficult task for the students. The preservice teachers gave them feedback based on these responses.

The exercise provided an opportunity to help the preservice teachers in many respects. First of all, it gave them practice solving non-routine math problems. Many of the students as Iowa State University that prepare to become elementary teachers have a negative attitude about mathematics and problem solving prior to the course. The heavy emphasis on computations in their own prior math experiences is an important influence on attitudes. Their attitudes began to change, however, as manipulatives were introduced, and as they gained more confidence in their own abilities to solve the problems.

In addition, the preservice teachers had the opportunity to work with "real" elementary students rather than merely speculating how students would deal with the problems in a classroom setting. Although it was still not the equivalent of working directly with students, the activity provided the opportunity to have some contact with students in a problem solving context. This gave the undergraduates practice in helping elementary students come up with a method for solving the problem. It gave them a sense of the problem solving capabilities of students who are challenged and motivated. It put them in a role of a math "mentor" that provided a powerful context to the problems that were sent and the communication that took place.

Although the main focus of this activity was to help the preservice teachers to develop skills in diagnosing and correcting student difficulties with mathematical problem solving, there were several other outcomes worth noting. One very positive outcome was that it gave the preservice teachers the opportunity to see how technology could be used effectively in a classroom situation. The elementary students perceived mathematics in a very positive fashion possibly because of the communications with someone other than their teacher. Also, the preservice teachers could see the applications of Internet use for more than just pen pal communications.

Another communication which occurred between the elementary students and the preservice teachers was also very positive. Students exchanged pictures (some electronically and some via more traditional means), to put actual faces to names. An on-line chat session was conducted with one of the schools having the capability of doing so, where live problem solving occurred over the Internet. Although the focus was mathematics, the college students and the elementary students had the opportunity to learn about each other as people as well, which gave the mathematics more meaning.

The activity was for the most part very positive. But there were some difficulties that were encountered at both ends. The students did experience some technical problems getting messages sent. For the college students, this was generally a result of not checking e-mail addresses carefully, but the elementary students at some of the schools had other difficulties. Two of the schools were just getting access to the Internet, so for them there were problems as a result of learning how to correctly operate their systems. As the semester progressed, the technical types of problems became less significant.

Some of the teachers involved with the activity were more enthused about participating in the project that others. Some of the teachers did not feel that the time involved in having students solve the problems and send their responses was well-spent. Other teachers (sometimes at the same school) felt that the activity was very beneficial to their students, and asked for more problems to be sent each week. Two of nine participating teachers expressed concern that some of the student groups were receiving the same problem as other groups, so groups were just giving other students the answers.

The biggest shortcoming was that some of the elementary students had difficulty explaining how they arrived at their solutions. It was the first time that many of the students had to write about how they solved a problem, so it was difficult for them to express themselves in a way that would be helpful to the preservice teachers' understanding of the process they used. Since the elementary education majors were not working directly with the students, it was important for them to get these description so that they had an understanding of where errors occurred. As the elementary students became more comfortable with their "mentors" and the idea of communicating about mathematics, descriptions did become much better. Also, the teachers that were participating in the activity worked with the students to help them become more skilled

The Internet Search Activity

In addition to the electronic mail activity, the preservice teachers explored the Internet to find and use information about the world. It was felt that future teachers needed to be prepared not only to learn how to access information, but also how to use the information in meaningful ways. They must be prepared to work with their students in a similar fashion. The activity to help them develop those skills involved cross-curricular themes: earthquakes and countries around the world. Each of the activities focused on the use of mathematics within these themes. These themes were explored by groups of three or four people in one class session using the Internet as a problem solving tool.

The first theme dealt with finding information about the South American countries using sources on the Internet. Students had to find specific information about each of the countries. General categories of information dealt with different math concepts: large numbers, percents, and conversion from kilometers to miles. After finding the information, students had to interpret the meaning of what they found. They then had to input the information into a spreadsheet and represent it graphically so that they could make a presentation to the entire class to share their findings.

A second theme was earthquakes. Students accessed a data base from the University of Michigan to find earthquake activity in the preceding week. They then made charts that showed the following information about each of the quakes: date, center, magnitude, and area where the earthquake was felt. They recorded this information on a map, defining a key that would be appropriate to best represent their information. Using a compass, they were able to show the area where the quake was felt. Dashed lines were used to represent aftershocks. Students made a presentation to the class to explain how they determined their key and the significance of an earthquake's magnitude.

The third theme was a mystery country that needed by be identified using clues from art, mathematics, geography, culture, and history. Once students successfully identified the country, they needed to search the Internet for the exchange rate of currency of that country in U.S. dollars. They had to find out how much of that country's currency they could get in exchange for $250 U.S. dollars. Their presentation was a description of how they identified the mystery country and how they figured out how much $250 U.S. dollars was worth in that country's currency.

Each of the activities had students using various navigation strategies on the Internet to find information. In the course of the problems, students learned to use several internet navigation tools such as Telnet, Gopher, and Veronica. Some students located useful information using Mosaic. The discussion following the presentation of each of the groups included the difficulties that they encountered while doing the activity, a description of the NCTM standards that were addressed during the activity, and how that or a similar activity could be used with elementary students. In addition, other activities were discussed that could be used to help expand the theme into a cross-curricular unit.

The Internet problem solving activities were not problem-free. Some of the student groups were not able to complete their Veronica searches because host servers were too busy. They did not have access to alternative telnet sites, so they had difficulty finding the required information. However, it was felt that the Internet exercise was effective in providing a model of how technology could be used with elementary students in problem solving situations.

Summary

It has been speculated that teachers teach as they were taught. Since classroom use of computers for non-programming purposes is still a relatively new idea, preservice teachers do not have many models from which to base their ideas on how to use computers and other technologies in their own classrooms. The activities described in this paper were implemented in a math teaching methods course for elementary education majors to give them technology-based approaches for the effective teaching of mathematical problem solving skills.

The Internet was found to be a very powerful tool that can benefit not only K-12 students. It can also be used to help preservice teachers begin to develop the skills that they need to successfully interact with students in problem solving endeavors. It can also help them to see how to use the wealth of available information on the Internet that can be used in a way that makes mathematics more real. Although the Internet was not the only technology tool used in the elementary mathematics methods course, it was a tool that had a major impact on the students. Preservice teachers increased their own mathematical problem solving skills, they learned how to predict student errors in problem solving situations, and they learned how to provide helpful feedback when students could not solve a problem. They also learned how information about the world can have meaning in the mathematics curriculum. Use of the Internet in a mathematics teaching methods course provided preservice teachers with opportunities to become better prepared to help their students increase their mathematical problem solving skills.

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The Use of Student Tutorials in a Mathematics Education Course

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As a teacher educator, I have accepted the challenge of including various technological resources in my teacher education courses. Some of the technological resources I have used includes multi-media presentations, videos, audio-taping, networking, and the use of educational software. I have found one of the most significant technological resources to be student tutorials on the computer.

The student tutorials used in my undergraduate elementary mathematics teacher education course were created using the software *Toolbook* by Asymetrix (1989-1991). These tutorials were loaded on computers located in the education computer lab that is available for students' use. Students were instructed to go through these tutorials on their own time and were given a certain period to complete them. The content of the tutorials changed as the quarter progressed. At this time, the students go through about three tutorials per quarter.

Through the use of these tutorials, teacher education students have had the opportunity to explore strategies in remediation and diagnosis, assessing student knowledge, and selecting manipulatives for worthwhile mathematical tasks. The tutorials are designed to be reflective exercises for the teacher education students serving as extensions to the concepts discussed in class sessions. Students complete written exercises from each of these tutorials to be included as part of their final evaluation portfolio.

In class, we discuss the usefulness of determining student error patterns as a tool for effective remediation. Through the use of the student tutorials, they are exposed to numerous examples that we do not have time for during class. As they work through these examples, the students are to determine the best strategy for student remediation. An example of one of the exercises is given in text in the next paragraph.

An example problem is shown such as 3/4 x 2/4 = 6/4 and instructions are given as follows: After instruction on adding fractions with like and unlike denominators, you begin your unit on multiplying fractions. One of your students completes a problem like the one shown above. What should you do? The choices are given: (a) Explain to the student that the process is just multiplying the numerators and then multiplying the denominators; (b) Coordinate some time for this student and a fellow student (peer tutor) to work out some multiplication fraction problems; or (c) Work with the student, one-on-one, using a grid sheet to illustrate what happens to the denominator in the process of multiplying fractions.

When students select one of the choices, a screen is prompted for feedback on that particular choice. After completing the entire tutorial, a screen will have information that gives students choices to the type of task they should complete as an assignment in conjunction with completing the tutorial. For this particular tutorial, the students were given the choices of either (a) writing a reflection of the significance of effectively determining error patterns, (b) making a list of possible error

patterns, one each in five topics in mathematics and explain how to remediate, or (c) interviewing a teacher to determine the variety of error patterns encountered in that grade level.

Alternative forms of assessment is a current issue that is always heavily addressed in this course. The students are exposed to both sides of this controversial issue through discussions, readings, posed debates, and reflective assignments. Through the use of the student tutorials, students are given the opportunity to continue to reflect upon the issue of assessment. The students are given classroom situations from which they are to select what they feel is the most appropriate form of assessment. An example of one of the screens from this tutorial is given text in the next paragraph.

You are planning to teach a mathematics lesson on regrouping in subtraction. How will you assess your students to determine if they are ready to handle this skill? (a) Give them a timed test on subtraction facts to determine a percentage of mastery; (b) Use base ten blocks to determine their level of understanding of place value; or (c) Give them a subtraction problem that involves regrouping and see how they do. For the follow-up exercise, the students were given the choices of (a) examining a teacher's edition of a mathematics textbook and writing a reflection upon the types of assessment used in one particular chapter, (b) writing a reflection of the suggestions made by NCTM in their evaluation standards, or (c) assessing three students using their own form of evaluation and explaining how they would use that information as a classroom teacher.

The National Council of Teachers of Mathematics (NCTM) has developed national standards for curriculum and teaching. One of the major documents written by NCTM is *Standards for Teaching Mathematics* (1991) which provides for teachers six standards for teaching mathematics. One of these six standards emphasizes the importance of teachers selecting worthwhile mathematical tasks. Since the NCTM Standards are emphasized as part of this course, one of the student tutorials takes the students through the process of selecting worthwhile mathematical tasks. An example of one of the screens from this tutorial is given in text in the next paragraph.

You are about to teach the basic concept of fractions to your third graders. Which of the following tasks do you feel would be most effective? (a) Use pattern blocks and have students determine fractional portions; (b) Use the introductory pages from the mathematics textbook; or (c) Have students determine fractional portions from shaded areas of figures on a worksheet. At the end of this tutorial, students were given the choices of (a) writing their own criteria for determining whether a mathematical task is worthwhile, (b) interviewing a classroom teacher to find out what types of mathematical tasks they feel are worthwhile, or (c) writing a letter to NCTM in response to their suggestions about selecting worthwhile mathematical tasks.

In the evaluation of the written responses students have included in their portfolios, I have found that using student tutorials extended their thinking about the teaching process. Many students have discussed some of the exercises in the tutorials during class discussions. From the initial student feedback, the most useful exercises are those in which error patterns had to be determined and possible solutions had to be suggested for remediation.

After using the student tutorials, some of the teacher education students in my course have created their own tutorials for elementary students' use in local elementary schools during field experiences. Some of the teacher education students created presentations using the computer to share with the class. Others mentioned that through the use of the tutorials, they felt more comfortable using computers on their own and became interested in using other types of software for classroom use.

I am in the process of developing more student tutorials for this course and research-oriented tutorials for graduate students. To extend this idea, my goal is to create tutorials for classroom teachers to assist their efforts in implementing the NCTM *Professional Standards for Teaching Mathematics* (1991).

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Multiple Indicators of Learning in a Computer Based Geometry Classroom

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The release of the NCTM *Curriculum and Evaluation Standards for School Mathematics* has spurred a reform movement that calls for more emphasis on the use of technology with evaluation as an integral part of teaching and improving instruction (NCTM, 1989). Implementing these standards requires that teachers be receptive to alternative approaches to teaching, specifically the use of technology, and assessment of student learning with technology.

Technology is already impacting how and what we teach in the mathematics classroom. Use of computer applications focusing on real life problems and allowing students to experiment opens the door to a wealth of problems that were not previously feasible. However, there remains a gap between the potential of the technology and the realities of the classroom. Even in classes where technology is integrated, assessment of student learning on the computer is lacking. In addition, recent books focusing on mathematics assessment do not deal with how to assess technology once it is implemented (Kulm, 1994; Romberg, 1992).

As teachers work to redefine their classroom with technology, assessment can serve as a valuable tool in curricular decisions. Assessments can be used to determine what the students have learned about both math content and technology, what learning strategies they are using, and how they feel about the use of technology in the classroom. In addition, this information provides valuable teacher insights concerning effectiveness of teaching techniques, use of computer applications, and effectiveness of integrating these two.

However, appropriate assessments must be developed and employed. Teachers must monitor student's comfort with and ability to use the computer, interactions with others while working, knowledge and usage of particular learning programs, and knowledge and application of specific mathematics content. Each of these types of learning require different assessments. In order to integrate technology effectively, teachers, at all levels, need assessment tools that help them understand what students are learning and which computer techniques are most effective.

Subjects and Procedures

This study was conducted in a college level mathematics course for preservice teachers majoring or minoring in math. There were two sections, each containing approximately 25 students.

The course was in informal geometry which focused on polyhedrons, similar and congruent, transformations, and measurement, and how they can be taught in the elementary school. Procedures used in class included problem solving activities, active involvement in learning mathematics concepts, open ended problems and cooperative groups both in the computer lab and regular classroom setting.

The emphasis of instruction was on group work and computer experimentation. Technology was integrated using the *Geometer's Sketchpad*, a program that allows students to make conjectures and "create" geometry. For example, students were asked to connect the midpoints of the sides of a quadrilateral. Students proceeded to "drag" a vertex of the exterior quadrilateral while describing the interior quadrilateral. Students developed their theories using the program. The instructor used this part of the course to focus on mathematics as a process, inventing procedures, and reasoning mathematically.

Alternative assessments were designed for each computer assignment which focused on knowledge of the computer, learning the program, knowledge of geometry concepts, and interactions with one another and technology. Some assessments were designed for this while others were adapted from *Classroom Assessment Techniques*, by Angelo and Cross (1993). Each of these assessments required students to write about their learning immediately following their work on the computer. For example, students analyzed the process of learning the *Geometer's Sketchpad* using process analysis. The intent in each assessments was two-fold: a) to help students reflect on their own learning, and b) to provide information for the instructor.

Results and Implications

When implementing computer technology in the mathematics classroom, several factors need to be considered. First, as in all mathematics courses, the emphasis needs to be on learning the math involved. However, when students are to do this using a new technique, the teacher needs to address several issues of prior knowledge and experience. First, the teacher needs to assess how experienced students are with computers. If many students are inexperienced, the teacher needs to take this into account and begin by teaching students how to use the machine. Second, while students may be knowledgeable concerning the computer, they may not be familiar with the software package being used. Especially in the case where an application focuses on discovery on the part of the student, attention needs to be given to the question of whether the teacher wants the student to learn both the software and the math through exploration or whether the learning of the software should be more direct so that students can simply use the software to explore the mathematical concepts involved. Finally, if students are to work in pairs or groups, the teacher may want to assess prior experience as well as the students' ability to work as a team. Below, we will discuss assessment tools that we used to evaluate mathematical learning using a computer discovery application in a college math classroom. We will also share some student responses and implications for teachers using technology assessments in the classroom.

Student Comfort with and Ability to Use the Computer

The purpose of these assessments were to evaluate 1) student prior knowledge and experience with computers and 2) student comfort with the computer. Two different assessments were used for this purpose.

The first was designed to give the teacher information at the beginning of the semester about student past experience and attitudes. This assessment included a structured list of questions that asked students to list computer applications they were familiar with and rate their experience with each program and different computer systems (Mac, IBM, Apple II), and how they felt about themselves as computer learners. Each rating used a Likert type scale from one to five. For example, on the question "How good at using computers are you?" students rated themselves from one (not at all good) to five (very good). Other questions included "Being asked to use computers in a math class makes me nervous." and "Experimenting (or playing) on the computer is fun."

Results of these questions suggested that all students had some experience with computers, usually word-processing on a Macintosh. In addition, student attitudes tended to be neither positive nor negative, averaging around a three on the one to five scale. Since students were somewhat familiar with computers the teacher did not have to start from scratch. In addition, there were few negative attitudes to overcome. A similar measure may be used at the end of the semester to determine whether student attitudes increase or decrease after experiencing a learning program like the *Geometer's Sketchpad* .

This assessment provides teachers with infonnation on the prior knowledge of students very quickly at the beginning of the semester. In this way, teacher plans can include a review of computer basics only if necessary. By measuring attitudes early and later in the semester, the teacher can assess the degree to which student attitudes change over time and make appropriate changes in instruction.

A second assessment was designed to provide more qualitative information than the assessment mentioned above. This assessment was given about halfway through the course when students had become familiar with both the content and computer application. The purpose was to explore how students thought their computer abilities had changed over time. Students were asked to pretend that the computer was a person and to describe in writing how their relationship with this person has changed over the semester.

Positive changes in attitude were evident in student's writings. For example one student wrote, "In the beginning, I really did not like the computer at all...This is just like a friendship because you might start hating the person but as time goes on and you spend more time with them, you learn to like them more. I don't think I could say the computer is my best friend but I can say we are much better friends now than we were just 6 weeks ago." This example points out how the student grew into a comfort level with the computer.

Another student wrote, "My relationship with the geometer's sketchpad at the beginning of the semester was as complete strangers....I was in tears for I felt I could not understand how to communicate....But, as I know with anything in life, something that is new and different takes time, time, time to understand. And I am overjoyed that I do know the language now and I can communicate with it 100%." This quote focuses on the change in the student's ability to communicate with the computer as well as their change in attitude.

This assessment gives students a chance to describe a foreign experience in terms of something familiar such as a friendship. It also encourages the student to reflect on and recognize their own growth. Reading these student writings can give the instructor a better appreciation for the level of frustration that is experienced by students during the initial introductory phase of learning a new piece of software.

Student Interactions with Others While Working

Students were given a choice between working on the computer alone or with a partner. This assessment was developed to encourage students to reflect on their effectiveness while working with or without a partner. Students were asked to give an example of something they learned from their partner and something they taught their partner. In addition, they were asked to suggest one thing they could do to make their partnership more effective. Students working alone addressed the pros and cons of working alone and reflected on what they might be missing by not having a partner.

In general, students with a partner found that they learned faster, helped each other with the mechanics of the program and reduced their level of frustration. In addition, they identified things that would help them to learn better together, such as sharing control of the keyboard, talking out loud (both verbalizing their thoughts and allowing for suggestions from the partner), and working slowly enough so that both understood how the process worked. Students without a partner often stated that a partner would have given them reassurance and provided a different perspective. In addition, some students used this opportunity to share with the teacher their concerns about partners. Some students who had partners did not want to continue with them, while some who did not have partners expressed the desire to work with another student.

As a result of these student comments the teacher could hold a discussion on how to work together effectively. This would include the need to share responsibility and communicate while working. In addition, this discussion in future classes could take place before students begin their work.

Another implication of this assessment concerns students requests to change partners. This assessment allows the teacher to gain insight into which pairs are having difficulty working together and allows for selective changes in group organization. This is especially useful since some students would not openly verbalize their dissatisfaction for fear of hurting their partner's feelings.

Finally, this type of assessment allows the teacher to examine comments made by individual students without their partner's influence. The teacher can compare each partner's ideas concerning the strengths and weaknesses of their work together and gain insights as to possible conflicts in communications, compatibility, or learning styles.

Student Knowledge and Usage of the *Geometer's Sketchpad*

The purpose of this assessment was to provide information on the processes used to learn the software, identify problems students were experiencing, and encourage student reflection on how they learn.

Students were given an assignment early in the semester to explore the Geometer's Sketchpad. They were asked to keep a running log of what they were doing on the computer, what they were learning, and what problems they were encountering. They were reminded to take notes at several times during the hour.

After the teacher read the above logs to gain insights into student understanding of the program, the logs were returned to students later in the semester. At this time they were asked to pretend they were a teacher reading a student's log and to respond to the following: 1) If you were explaining to another person how this student went about learning the Sketchpad, what would you say they did right and wrong based on their process log? and 2) What would you as a teacher do to help this student?

In response to this assessment, students were able to identify things that hindered and facilitated learning in their earlier work. Whether identifying things done right or wrong, most students focused on the need to spend time exploring, learning the basics of the program before moving on, and asking questions when all other avenues failed. Comments such as, "The student should have spent more time experimenting and learning how the program works before jumping into a problem," were common.

Upon reflections, students were able to identify strategies that would have made them better able to learn the program and less frustrated in doing so. Reading student responses made it very clear that the frustration felt early in the semester was directly related to the pressure of time. Students needed play time to explore and "fiddle" prior to any formal assignments. Structured play time for a minimum of two labs and a requirement that students spend a minimum of one hour in the open lab may have alleviated some of the frustration and made time spent on future labs more productive.

Student Knowledge and Application of Specific Mathematical Concepts

A "stop and write" may be used to assess specific learning. In this assessment, the student is given an assignment with at least two parts. When the first part of the activity is completed, students are to stop working and reflect on what they have done by writing about what they have just learned and the role of the computer in how they learned. This is repeated again at the end of the assignment. The purpose of this assessment is to provide a window into student thinking while they are working on a project. It is an effort to look at the process in addition to the final product of a particular assignment. In this particular computer assignment, the first part of the assignment gave students the opportunity to practice basic geometric constructions of altitudes and medians and in the second part of the assignment, students applied these concepts in a real life context.

This technique allowed the teacher to observe the influence of part I of the assignment on the more complex part II. For example the following student found part I frustrating even though the knowledge gained in this part positively impacted her success in part II. In part I she wrote, "I became frustrated with the operation of the computer. I concentrated on the operation of the computer program, and did not retain my ideas of medians and altitudes." Then in part II, the same student stated, "I used some of what I learned in part I, like finding medians and altitudes. The computer was somewhat easier to use, I found it a help this time."

In addition, comments such as, "By trial and error the computer has taught me how to construct the various bisectors," and "Using the computer makes the concepts real because I can visually see the concept," demonstrated that students were using the computer to help them understand and expand on geometry concepts.

Through the use of this type of assessment, the teacher can observe student processes during an activity. By using a technique such as this one where the first part of the assignment deals with basics, students get their frustrations out so they have more success on the more challenging problem that follows.

Both teacher and students observed that the computer application facilitated learning and allowed for extension activities involving geometry that would not have been possible with traditional methods. When using this type of application, teachers can ask higher level questions than they previously could have. In addition, technology becomes an aid to learning geometry concepts.

Another type of assessment that can be used to assess student knowledge of mathematical content is the word bank. The purpose of this open-ended assessment is to have students develop connections where no direct connection has been given by the teacher. Students are given a list of terms that may or may not go together and asked to write a paragraph using some or all of the terms showing how the concepts are related. For this assessment, students were given the terms ratio, legs, right triangles, tangent, increasing, decreasing, cosine, similar, exponential, congruent, function, domain, and scalene. The computer lab activity, using the *Geometer's Sketchpad*, centered on the construction of similar right triangles and an exploration of the ratios of the lengths of the legs of those right triangles. Student paragraphs were reviewed for the degree to which they were able to make multiple connections among mathematical concepts. Specifically, students were expected to make connections among triangles and trigonometry.

In an analysis of student paragraphs, the teacher looked for the complexity of student observations and connections. In a basic response, students made rudimentary observations and were not able to see complex relationships. For example, one student wrote, "In this lab we used right triangles. We found the lengths of the legs. The ratio between the two lengths would not change whether the lengths were increased or decreased."

Student responses are more elaborate when they have developed an understanding of basic relationships among concepts. For instance, a student at the other extreme wrote, "I learned that in a 30-60-90 triangle the length of the shortest leg is exactly one half the length of the hypotenuse. Similar right triangles proved that the lengths of their legs always have the same ratio. This was interesting because the lengths of the legs were different and even if the angles of the right triangle were different the ratio of the legs was always the same if the triangles were similar. I found that in a right triangle, the ratio of the length of the legs is equal to the tangent of an angle of that triangle. When the angle measured got larger the ratio of the length of the legs got larger too." Although both students used the same word bank, this student was able to make connections among the lab activties and their own prior knowledge of trigonometry.

Although this was not a trigonometry class, the use of a word bank asked students to make connections between content being taught in this class and topics that were learned earlier. These connections are not easily made by students. Although teachers may design activities with the intent of having students make connections among topics, students have difficulty seeing "the big picture". Word banks have the potential of communicating to students that the instructor values the students' ability to make mathematical connections. They also force the student to think of the immediate content in relation to prior knowledge.

Conclusions

In order to assess the variety of learning taking place when computers are integrated into the math classroom, different kinds of assessments need to be considered. These assessments provide teachers and students with feedback concerning learning as well as information on how to improve instruction.

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Exploring the Potential of Teacher Created Multimedia Materials as a Staff Development Tool

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Teachers must learn children's mathematics through interactive communication with them, just as children must interactively build up their mathematical knowledge. The adaptations on the part of both teachers and children involve constructing concepts that they may or may not currently attribute to their mathematical reality (Steffe & Wiegel, 1992, p. 449).

The Center for Applied Educational Technology (CAET) at Cleveland State University together with a mathematics educator and Lomond Elementary School have embarked on a new venture in using technology to develop alternative professional development programs in mathematics education. The goal of this collaborative effort is the creation of a mathematical learning vignette database for use in teacher enhancement and teacher preparation programs. The vignettes will provide the user with glimpses into students' mathematical constructions. The elementary school teachers play a unique role in this endeavor. These teachers not only design, modify, and teach the lessons which are filmed, but are also involved in making the initial edits of the video footage. This paper will discuss the collaborative partnership between elementary school teachers and university personnel in the creation of multimedia materials for use in the teachers' own professional development.

System Development—PERSPECTIVES

The teachers involved in this project are participating in a professional development program, PERSPECTIVES, which is focused on changing mathematics instruction. This program endeavors to cultivate teachers as critical connoisseurs of instruction (Cowen, 1994; Eisner, 1991). In particular, PERSPECTIVES focuses on helping teachers develop a critical eye in terms of mathematics teaching and learning.

System Error

The original goal of the project, as stated in the grant proposal funded by the Ohio Department of Education, was to create performance tasks/benchmarks in mathematics for two purposes: (a) to assess the mathematical understandings of fourth grade students and (b) to target the K-3 mathematics program toward these benchmarks. However, a dilemma arose when the teachers realized that the development of a performance task, a benchmark, a culminating experience, or project was contrary to their developing belief in how children learn. For four years the teachers had been committed to implementing the *Standards* (NCTM, 1989) and changing the learning environments in their classrooms (Cowen, 1994). Their commitment led to the investigation of an alternative epistemology, constructivism (von Glasersfeld, 1990).

The conflict between the definition of the task and their evolving beliefs about learning sparked a series of heated discussions in which the project development team was hardpressed to make a distinction between a test and a performance task or a test and a benchmark. Teachers came to believe that whether it was called a performance task or a benchmark it was still a test. This would give the message to teachers and students that some instructional activities (tests) were more valid indicators of student learning than the instructional activities which preceded the test. That is, that some activities were designed as practice for the "real" activities which determine what the students know or do not know. It seemed to devalue all of the students' hard work on tasks which were not benchmarks/performance tasks/tests.

Debugging the Program

The teachers sought to develop strategies for "leveling the academic playing field." That is, we would design a professional development program which would help teachers value and evaluate **all** learning. The question then was how do we "level the playing field?" What do we use to determine what students know about mathematics? The answer was language. It was decided that one method for inferring student understandings was through mathematical discourse.

As mathematics teachers, then, we have the responsibility of learning the mathematical knowledge of our students through interpreting their mathematical language and actions and on that basis making decisions about what their current mathematical concepts and operations might consist of and about what they might learn. These decisions are a crucial part of teaching and are a means whereby we can harmonize our teaching with our students' learning (Steffe, 1990, p. 45).

The project development team sought to design a program which focused on conceptual understandings in mathematics versus performance outcomes. The conceptual understandings would be inferred through the analysis of student conversations about mathematics. The team believed that this analysis of student thought would provide teachers with opportunities to deepen their own mathematical understandings.

Implementation of Program

Teachers involved in PERSPECTIVES meet once a month for a full day inservice session. The program is designed to provide participants with opportunities to engage in mathematical activity, view children engaged in mathematical activity and continually seek to determine the potential concepts inherent in an activity as well as student conceptual understandings. It is believed that:

1. Viewing children engaged in a mathematical activity previously experienced by participants will enhance the development of both content and pedagogical understandings;

2. Analyzing the conceptual understandings of children by "listening in" on mathematical conversations will provide participants with an opportunity to increase their own mathematical understandings;

3. Engaging teachers in developing the technology for future professional development use will allow us to test the materials as they are being created.

Materials Development

The production of the video learning vignettes requires the cooperation of the PERSPECTIVES facilitators, the school building administrators, teacher participants, students, and CAET. The initial phase of material development involved the following steps:

1. At the monthly inservice session participants engage in one or two mathematical activities developed by the PERSPECTIVES summer writing team (a small number of the PERSPECTIVES participants);

2. Select teachers engage their students in the same mathematical activities during the hiatus;

3. The CAET staff tape the students engaged in the activity;

4. The CAET staff create time coded VHS dubs of the 8mm tapes;

5. At the next monthly inservice session participants work in small groups to conduct the initial analysis of the rough video footage. Each group is given a recording sheet which includes a space to record the starting number, ending number, and math activity name. In addition, participants are asked to state the reason(s) for choosing the segment as well as the mathematical understandings shown in the segment.

The CAET-school partnership is vital for capturing student conversations about mathematics. This partnership will produce a learning vignette database created by teachers, tested by teachers, and available for use with future PERSPECTIVES participants. This partnership also provides CAET with an opportunity to expand its role in the creation of multimedia materials. Prior to the commencement of the PERSPECTIVES-CAET project, CAET purchased Hi-8mm camcorders. For the first time the CAET staff is responsible for the actual filming of all lessons. This provides the additional challenge of learning to effectively use the cameras as well as lighting and audio considerations. Additionally, the CAET purchased editing equipment. This provides the CAET staff with complete technical control of the final editing process. It will also enable at least one of the teachers to be involved in the editing process.

Bugs

We try to limit the taping of the mathematics lessons to one day. We also try to limit the number of lessons for a day's taping to three. Needless to say, the taping of the mathematics lessons has not gone without problems. For the first lesson we used two cameras and had the children working in small groups. Approximately 24 students were in the room at the time of the taping. We found that it was very difficult to hear the student conversations. Since the goal of the project is to capture student mathematical conversations we decided to limit the number of groups in the room.

For the second lesson we filmed two groups with five children per group. The lesson was conducted by the regular classroom teacher in the school library. The remainder of the class was taught the same lesson in the classroom by the assistant principal. We found that the two groups of children chosen for this taping were not accustomed to working with each other. Consequently, there was not a lot of talking between group members. Additionally, each group member was given their own copy of the activity sheet which provided the children with an opportunity to work individually.

In editing the two activities PERSPECTIVES participants voiced concerns over the setting for the second lesson. It was believed that the children were required to be quiet in the library. Perhaps this hindered potential discussions between group members. Participants believed that if the taping were done in the classrooms students would feel more comfortable. Consequently, students would be more likely to engage in conversation.

Adjustments were made for subsequent filming of the lessons. Teachers were asked to watch their students engaged in cooperative tasks prior to the taping in their room. They were asked to notice which students seem to work best together and talk with each other while solving problems. These students should be selected for the taping of the lesson. The number of student groups which would participate in the taping was limited to four with two or three students per group. Each group was given one copy of the task to encourage collaboration and discussion. The lesson was held in the regular classroom. The remainder of the class was taken to the library and taught the same lesson by the assistant principal. This was done to prevent parent concern regarding the differential treatment of students. We found that this model did increase both the quantity and quality of discussions.

Nevertheless, we did find that we were still experiencing difficulty in eliminating excess background noise and in capturing the conversations of the group being filmed. This was remedied by ensuring that the camera was directly in front of the group being filmed and not off to the side. This required that the CAET staff have room to move between the groups.

We have reached a point at which we are comfortable with the technical aspects of the filming process. However, we have encountered an unexpected predicament in the initial editing process. As the teachers become more sophisticated in their own mathematical understandings and in their ability to infer the mathematical understandings of students we have found that they are more critical of the mathematical task being used. That is, the teachers' conceptualization of a rich mathematical task is continually evolving. Consequently, the teachers are very critical of the video segments which they are willing to include in a final product. This quandary has forced the PERSPECTIVES facilitators to provide additional opportunities for teachers to critique and revise the task prior to using the lesson with children. It has also focused attention on the importance of questioning in developing rich mathematical problem solving activities and in facilitating problem solving lessons.

Summary—Quality Assurance

As a result of our initial work in developing a mathematical learning vignette database we have found that:

1. Filming the lesson in the students' natural environment promotes discussion;
2. The number of student groups being filmed should be limited to accommodate the physical layout of the classroom and the number of cameras used;
3. In selecting students to participate in the filming attention must be given to group dynamics;
4. Providing students with a limited number of copies of the activity sheet and materials promotes discussion between group members;
5. Questioning techniques enhance the quality of discussions held between group members.

The consideration of each of these components has enabled the project team to fine tune the process for preparing a teacher created database of mathematical learning vignettes.

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Student Use of Technology to Build Links Between Mathematical Variables: Implications for Teacher Education

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This paper will present a detailed example in which students used technology, in this case a fairly sophisticated authoring system - ToolBook, as a tool to construct their own understandings in mathematics. In doing so, they were able to address two of the more demanding needs in mathematical problem solving: (a) to successfully identify the variables (unknowns) and the information given (data) in the problem and (b) to create links between the data and givens which enable successful problem solution. Technology was a crucial element in this effort by serving as a powerful means of representation for the developing student insights.

This work was done in a seventh grade pre-algebra classroom of below average ability students in a middle class urban setting. The results reported will focus on a single classroom and the classroom teacher whose voice we hear in the "quotes from the field" section. The curriculum used was conceptually based and utilized a five phase approach which allowed students to construct mathematical intuition via physical materials and computer usage (Connell, 1993, Connell and Peck, 1993). In this approach, the initial two phases make use of physical materials in a much different fashion from traditional approaches. Rather than using manipulatives to demonstrate procedures or rules, problems are posed which require active student involvement with physical materials to model mathematical situations, define symbols, and develop solution strategies via actions with the materials. As the children use these physical materials to solve problems, they actively construct operations and principles of arithmetic. The third phase uses sketches of physical materials and situations experienced by the students to encourage a move toward abstraction. The sketches then serve as the basis for additional problems and as tools for thinking. In the fourth phase, the children construct mental images through imagining actions on physical materials. The experiences with mental images provide a basis for the fifth phase where students constructed strong arithmetic generalizations and problem solving skills through scripting their developed understandings on an IBM computer using ToolBook.

As a consequence of the instructional sequence outlined above, the children constructed a series of related mathematical concepts. The computer played a pivotal role in this project, albeit a much different role than that usually associated with CAI. Rather than using the computer for it's speed, the computer's patience and need for exactness of logic and clarity of expression was utilized. The computer assumed the role of an active listener that would do exactly what it was told, as opposed to a pre-programmed instructor requiring a specific type of answer. The computer became another "tool" available in the students' ongoing efforts to construct meaningful methods of dealing with the problems they encountered. The nature of this "tool", which was provided for the students to "think-with", came to shape their performance and cognitive styles. When a computer was available for the students' use, the problem solving situation shifted toward the identification and selection of what data to include in the problem, identification of the problem goals, and choice of appropriate procedures and control statements to obtain and verify the desired results.

It is in regard to this last observation that the bulk of this paper will focus. The students were routinely able to successfully identify the variable(s) and information (data) necessary for successful problem solution and were then able to construct appropriate linkages between these items. This was done in a very dynamic fashion in which the representations constructed by the students using the computer reflected their own ongoing construction of meaning.

It should be noted that although students constructed their own representations and solution methods certain 'family resemblances' among approaches can be observed. It is on these 'family resemblance's' that the discussion of student work will be centered. These may be outlined as follows. (1) Students began by using the sketch tools to create a working sketch in which they tried to capture the essence of the problem. This is in keeping with the curriculum focus and seems to indicate a tight linkage between the curriculum and the technology. 2) Once the sketch was in place, students created fields which were then named to correspond to variables. The need to create and label a field for each piece of information appears to have been highly helpful in their thinking. Spreadsheets, which allow for immediate numeric input, do not offer this same opportunity for conscious reflection. 3) Buttons were scripted which linked the created fields in an effort to solve the problem at hand. In doing so, the students were required to consciously link the identified information

Differences between this approach and typical spreadsheet applications will be noted. In particular, the drawing tools of ToolBook and the ability to create almost any representation the students could conceive served to liberate the student thinking and allowed for a more natural integration as 'just another tool' in the classroom.

A Teacher's View - Quotes From the Field

Our goal this year was to approach the learning of mathematics in a way that enables the student to construct their own meaningful understanding of math concepts. In so many ways the progress of the project met and exceeded our expectations.

Two of the pre-algebra teachers participated this year by teaching two pre-algebra classes each. One class was a traditional class using the pre-algebra textbooks and one took part in the project. Michael Connell and Don Peck, who are professors at the University of Utah, gave us insight and direction in the project and modeled teaching techniques in our classrooms. Speaking as one of the teachers that participated, I was quite excited to start the project because the need to break away from teaching math in fragmented, unconnected sequences was glaringly obvious to me as I watched students struggle to find relationship and connection.

The first task was to reverse the roles of "student" and "teacher". I am not sure who had a more difficult time getting used to this, the students or the teachers. The teacher must be the doubter, questioner, and skeptic. The students must be the explainers, solvers, and defenders. After setting up a scenario and posing a problem, we let the students work together to find patterns and reasons for what was occurring. It was very unsettling to the students to struggle to find words to describe and reasons to justify the discoveries they made.

For the teachers it was all we could do not to jump in and explain. As teachers we are so accustomed to being the "source of understanding" for our students. I found myself worrying that the students would find this to be too strenuous and would give up. Perhaps it is too much for them and they would not find solutions or explanations at all. Then the most amazing things started to happen. For example, one day early in the year we were discussing positive and negative numbers using the framework of hot cubes (positive numbers) and cold cubes (negative numbers). Dr. Connell and I had posed some problems and were walking around discussing and listening to ideas and explanations with the different groups. We wrote down the different answers proposed by the groups and began listening to the discussion. Before long, we had quite a lively debate going on with groups defending their answers.

One group was holding out because they were convinced their answer was correct. After much discussion we all finally had to agree. Witnessing this lively deliberation of a mathematical concept was a pivotal point for me. I realized that students have marvelous capabilities in reasoning and understanding. The motivation is right there in the mathematics if we just give them a chance to discover it. As we went along I found students willing to risk themselves in proposing solutions even if their results were not found to be true. In deciding the accuracy of their conclusions, the students began to examine their own understandings instead of looking to the teacher to approve or disapprove. (Learning to have a poker face was one of my biggest challenges.) It was not uncommon to find myself being followed around after class by a very persistent explainer. "Oh please...let me explain..." became a common petition as students began to recognize the power of their own minds.

When we started this project, Dr. Connell told us that it would take until Thanksgiving to be thankful and he was right. We all had to learn a new way of thinking. I distinctly remember a definite sign that the role reversal was becoming reality. We had just started discussions that would lead to the factoring of polynomials. I posed a problem on the board and the student who answered said, "Well the answer is....*because*...." and without a moment of hesitation she went on to explain why.

During the year we worked on concepts and problems reaching beyond "pre-algebra" topics. Factoring polynomials is a concept that haunts Algebra teachers and yet when discussed as an extension of simple arithmetic it just logically rolled out. In fact, we investigated problems such as the concept of "limits" (the plague for calculus students) and had some very spirited exchanges. A time or two, I had no idea what the answer was myself; but if I just waited, a student would be sure to explain it to me.

In all of this, probably the most memorable moment came when I was talking with one of my students as we passed in the hall. She said to me, "I never knew I was a smart person until this year in math." She is an incredible and diligent thinker who is confident in her ability to use her own mind. This newly discovered belief in self was experienced over and over in this class. If a student walks away from a math class feeling like (s)he can tackle a problem and succeed, then new challenges are opportunities not obstacles.

As for difficulties and set backs, there were some definite challenges. As we move from investigating to predicting to reasoning to generalizing on each concept, one of the key ingredients is a computer. After a concept has been explored and explained, the students program the computer to do any problem of that kind. The computer forces them to develop the algorithms that the computer uses to solve the problems. They teach the computer to think. In order to do that, they need access to the computer. Our computer lab was supposed to be up and running by September. It did not happen until April. In the meantime, we had four computers for two classes of 36 students. The students found so much reinforcement and enjoyment in writing their own programs that they would come in during lunch and stay after school. The lack of access was a great disappointment and it certainly slowed our progress. Another experience that disturbed me was that there were several students who never did quite "buy in" to what was happening. I do not think their experience was a negative one, but it was true that it fell short of what I hoped it would be. This year as we continue the project, our focus will be finding ways to encircle all students.

This project has ruined me for teaching the way I have in the past. Teachers often complain that students "refuse to think for themselves", yet how can we expect anything else when we view ourselves as the teachers and explainers and the givers-of-knowledge? Our students were not alone in their discovery that the enduring motivation to learn and understand comes from undertaking and overcoming the problems yourself, not watching and waiting for someone to do it for you. We look forward to continuing and expanding this project.

An Academics View

The computer has brought into question the need for children to memorize algorithms for the mechanical processing of numerical data. Yet, there is a need to learn to create algorithms for the purpose of communicating with the machines and bringing them under control. An additional hope engendered by technology includes a unification of real world experience, arithmetic and algebra into broad conceptual constructs which empower students to more fully engage in crucial aspects of mathematical thinking and problem solving essential to modern society. This project has aimed at these goals.

The advent of scripting languages such as ToolBook and its' scripting language OpenScript, (or, it might be added HyperCard and its' scripting language Hypertalk) whose syntactic requirements are relatively simple and are conducive to expressions in algebraic terms represents a major advance in tools to aid in student thinking. Although HyperCard has been used for this purpose at other cites, it was ToolBook which represented the software which was used in these experiences. As Ms. Crimm (the teacher whose viewpoint was shared) noted, the equipment initially available for these particular students consisted of only four IBM 386 computers equipped with hard drives and the companion software ToolBook. It was not until much later in the year that the students were able to work on similar computers in a laboratory setting.

The introduction to the computer was accomplished in five phases. In keeping with the notion that children learn best through their own investigations, the instructional sessions provided only the bare essentials of entering the machine and basically communicating with it via scripting buttons. The growth in expertise and mastery of the machine was to be cooperatively developed by the children as they communicated the mathematical generalizations they formed from their class experiences to the machine.

Physical materials provided a common externalizable alternative to the formal axioms and were used in this instructional program for the express purpose of building personal meanings on the part of the students and establishing a firm foundation upon which the powerful abstractions of mathematics could be safely constructed. In practice, problems were posed which formed a basis for the concepts at hand, and then questions were asked which required the students to use the materials to solve the problems and make decisions. No rules allowed.

As Ms. Crimm pointed out, in the instructional program the instructor and students reversed traditional roles. This reversal was done quite consciously and for well defined reasons. It is important that the children do their own thinking based upon experiences to which they relate and upon which they can construct meanings to guide their thinking and problem solving efforts. Thus, when teacher and student roles were reversed, it allowed the teacher to model effective learning strategies for the student in a unique fashion. It required the student to more fully develop and justify their own understandings to hold up to adult scrutiny and requirements for well-developed discussion.

Reversal of roles assured development of independent thinking and problem solving on the part of the students and prevented the teacher from filling the student minds with his or her understandings; instead it allowed the students to construct their own knowledge. Realization of the goals of mathematical thinking and problem solving would be impossible if the course was taught by drill, by lecture, by telling students how to do the problems, or by other popular methods which would insulate the students from complete immersion in conceptualizing for themselves or which precluded the necessity for them to solve problems daily and determine whether they had solved them sensibly. Thus, the instructor became a problem poser and question asker. Students solved the problems and explained their solutions. No answers were given by the instructor. Using physical materials from which to reason, students were expected to find ways to confirm their own decisions about the sensibility of their results and defend them to their peers and the instructor. They worked in small groups of up to four and shared their thinking and reasoning. They then had opportunity to share their thinking with other students in the class and explain how they solved the problems and how they knew their decisions were correct.

A mathematics inventory developed by the author was used to gather student pre and post data. This assessment had been used in earlier studies and mapped tightly to the curriculum of the school. Validity controls were constrained to face and content validity as determined by the teachers and investigator taking part in the study. It should be noted that an earlier extensive cooperative effort with a district level evaluation team (from another state) had been undertaken in test construction in which extensive item analysis was performed to select the best items and establish the item to objective mapping used in this study. Reliability estimates using Cronbach's Alpha were calculated for both pretest (alpha=.74) and posttest (alpha=.84) versions of this inventory.

An examination of the pre and post total scores for this classroom illustrate that significant growth was made during the course of the year. A t-test on these scores found a mean difference of 5.68 and a value for t of 5.96 which was significant at the .001 level. In looking at the content areas measured, several increases worthy of notice in light of the instructional focus spent during the year support previous research (Connell and Peck, 1993; Peck & Connell, 1991). In the areas of Extended Mathematics (pre-algebra) Problems, Miscellaneous Problems (which required a variety of problem solving strategies, and Estimation (which although not formally discussed was inherent in all student work) that the greatest increase in student performance may be observed. A near doubling in student performance in each of these areas provides strong evidence that the instructional emphasis upon student problem solving was effective for this group.

Additional support for this approach was found in examining the consistency of student responses. Modified Caution Signs were computed for the students using the pre and post assessment (Sato, 1991). This index may be interpreted in the following manner: an A type response indicates high levels of performance and consistent patterns of item response, B indicates high performance and inconsistent response, C indicates low levels of performance and consistent responses, while D represents low performance and inconsistent patterns of response. The number of students identified as having type A responses (High and Consistent) nearly trebles over the course of the intervention while the number of students in B (High and Inconsistent) increases. This is accompanied by a corresponding decrease in the number of students showing a C (Low and Consistent) or D (Low and Inconsistent) response patterns.

Implications for teacher education

Technological tools in mathematics at the elementary level have been traditionally perceived as computer programs which automate specific problem types, calculators and spreadsheets, and programming languages - most typically LOGO. With this background it is not surprising that their impact has been more to replace the labors of computation while offering little in terms of focusing on student problem solving.

The case of the solution in a can program, as exemplified by the automation of a particular class of problems, is the most disturbing of these examples presented. This approach not only eliminates the need for any student thinking whatsoever, but so trivializes the problem itself as to make its nuances and learning potentially nil. Although it is of great benefit to have programs which compute loan amortization, for example, examination of the output of such programs does little to teach the application of compound interest. Not only are the computation and solution paths masked in such programs, but the student has no opportunity to understand what the answer really means - let alone how it was derived.

Calculators and spreadsheets, although significantly more promising, likewise suffer from deficiencies when applied to classroom instruction. The primary difficulty of the calculator lies not in its potential, but in it's implementation. Calculators are typically used, for example, as a means of checking student work originating from drill and practice applications. Calculator problems tend to focus upon the application of a predetermined process for a specific problem and often lead to unintended difficulties. Furthermore, over reliance upon them at too early a point often reinforces student beliefs of inability and does not lend itself to the development of broad conceptual underpinnings for the operations which they so speedily and accurately perform.

In addition to a widespread perception that calculators are not appropriate for elementary school children, spreadsheets suffer from a similar fate. They are closer to the paper and pencil methods used by children, however, in their row and column orientation which parallel traditional methods of problem solution. With the development of integrated powerful graphing features they also allow for a broader range of representation possibilities *still within a finite set, however* than is present in the standalone calculator alone. As with calculators, however, they are a black box to the student with only the outcome being visible. The methods of solution which lead to the answers and the rationale for the methods remain invisible to the student - thus weakening their potential applicability.

This is an extremely important point. Goldenberg (1988) notes, "Software that graphs automatically from left to right sweeps over a domain in x without any student involvement and leaves the student active control only over the functions' parameters. In other words, the variable is not variable for the student but the constants are. Because the variable and constants switch roles in many graphic packages, the unthinking use of such software may obscure rather than clarify this difficult concept. All the potential problems....assume that the students *think* even if only naively about the graphs. However, there is also the possibility that a novice to graphs would dismiss graphs completely as *How the computer behaves when you type x's into it.*"

In this case, as in many others, the very features which contribute to making a calculator and spreadsheet graphing suitable for a skilled user - speed, accuracy, flexibility, etc. - make it unsuitable for a student attempting to construct an understanding of what is meant by a graph. We must provide more than a black box which always gives the right answer; the box itself must be transparent and its methods analogous to those ultimately desired of the student. The work reported in this paper illustrates an alternative to these approaches which places the student in control of the computer. This in turn results in the student being in control of the content.

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The Skymath Project

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The University Corporation for Atmospheric Research (UCAR) has received funding from the National Science Foundation to prepare a middle school mathematics module incorporating real-time weather data. The goals of the pilot project are to demonstrate that acquiring and using current environmental and real-time weather data in middle school classrooms, in ways that embrace the dynamic and the uncertain natures of these data, will promote the teaching and learning of significant mathematics, consistent with the standards set by the National Council of Teachers of Mathematics.

The project, called Skymath, is led by a Design Team of mathematicians, mathematics educators, scientists, technology experts, and teachers; this group reflects the interdisciplinary nature of the program and its emphasis on the use of technology in a science/math school environment. The technology component will make use of the Internet and the "Blue Skies" program at the University of Michigan, an innovative and successful program that provides weather and other environmental data in graphical, textual, and numerical modes for K-12 classrooms.

The Skymath educational strategies and materials will be prepared by the Education Development Center (EDC) of Newton, MA, a nonprofit research and development organization, in a flexible curriculum module that includes guidance and tools for exploration plus a collection of resources and activities that use weather and real-time data to teach math concepts. The end-product will be a loose-leaf handbook, available in on-line or hard-copy form. It will contain a series of activities accompanied by: suggestions for sequencing, assessment strategies for evaluating what students learn and understand, help (for students and teachers) with technologies needed in the classroom, a narrative describing successes and obstacles that have been encountered in the use of Skymath concepts, and an invitation to assist in further module development.

We have had lengthy discussions on the costs and benefits of classroom access to real-time data. Computers with Internet access are costly. Real-time data can be messy and may impose scheduling constraints. Yet we believe that experiences with such data are critical for students to understand the power of mathematics and technology and to become effective problem posers, analysts, and solvers. Skymath will help lay the foundation for such learning experiences. Enabling students to access data about weather *as it is happening* provides an element of excitement that is otherwise difficult to produce in a classroom, and watching the evolution of certain phenomena can be emotionally gripping. Research (Songer, 1994) has shown that when students have the opportunity to share their own *current* data with other students in distant sites their learning is enriched. The use of the Internet in student investigations adds importance, lends excitement, builds an audience, and gives face and embodiment to numbers that might otherwise be dry and uninteresting.

Skymath will utilize software and data dissemination methods developed in the University of Michigan's Blue Skies program, an endeavor created under a National

Science Foundation grant. Blue Skies software offers an extraordinarily simple interface so that users with a minimal computer experience can easily and quickly obtain needed information. Access is provided to hundreds of real-time weather and environmental images by using the client-server protocol developed for the University of Minnesota's "gopher" system (though Michigan dubs the information-providing components "groundhog" servers, apparently in light-hearted deference to collegiate rivalries). Unlike the typical gopher counterpart, the Michigan "client" software handles special Blue Skies documents that provide high levels of graphically-oriented interactivity.

Unique to Blue Skies are Interactive Weather Maps, which contain images (depicting, for example, pressure patterns, radar reflectivities with fronts, satellite views, etc.) in which current conditions and forecasts are embedded as textual information. There are cities plotted on the map and, as the mouse-driven cursor passes over them, the current conditions (temperature, wind direction and speed, etc.) are shown instantly as text on a status bar. If the user clicks on one of these cities, the latest National Weather Service forecast for that city is displayed. The user also may zoom in on selected regions of the country, allowing more cities to be displayed and permitting detailed exploration of weather phenomena. For schools participating directly in Blue Skies, there are features that allow students to enter their own weather observations, and these soon appear on the detailed regional maps that are accessible to all users of the system.

Such interactivity allows students to explore many basic questions of science and meteorology, such as "What are the changes in winds, temperature and relative humidity across a cold front?" or "What is the relationship of precipitation and clouds to low pressure systems?". However, the Skymath Design Team was challenged to focus on what *mathematics* could be learned through this wealth of data.

In an article published in the Mathematical Sciences Education Board's *On the Shoulders of Giants*, Ian Stewart (1990) discusses mathematical concepts related to "change." Noting that every natural phenomenon is a manifestation of change, Stewart stresses that mathematics is the most effective tool for understanding patterns of change. He notes that to master the concept of change, one must be able to "*represent* changes in a comprehensible form, to *understand* the fundamental types of change, to *recognize* these types of changes when they occur, and to *apply* these techniques to the outside world."

The Skymath Design Team identified the mathematics of change as the most natural to address in a module that utilizes current weather data. The module could articulate a mathematical study of the changing weather, leading students to understand what changes and what doesn't and to measure, represent, and analyze these changes. Activities can include developing symbol sets, preparing graphs for median-based analysis, predicting magnitudes of changes, and learning about the correctness of their work by seeing what really happens!

Thus this module will address the mathematics of prediction, especially probability and statistics. Typically difficult to teach and understand, these subjects are natural in the Skymath model. Thinking about how the real world changes with time and recording real-time data to accumulate a time series are activities that will evoke student ownership of the data and will provide experiences that retrospective data cannot. If a day is missed, the student has to account for that when creating a time-series average. The combination of local data gathered by students with data conveyed electronically from around the world (depicting today's weather) can stimulate curiosity about natural variability and hence about the quantitative nature of change in spatial as well as temporal dimensions.

This Skymath strategy may be characterized as helping teachers utilize purposeful tasks to teach important mathematics, tasks which elicit higher-level thinking and call for reflection and communication, consistent with the NCTM standards.

The tasks of the first Skymath module will flow from off-line experiences (getting familiar with weather measurements) to on-line collection of data, i.e., from small data sets to larger, computer-based data sets. The focus is on learning through questions and problems that motivate students by incorporating real data and authentic tasks, and through culminating projects which stimulate students to conduct their work with an audience in mind. A potential activity will have students collect and analyze data to select the best city for an amusement park or a recreation facility.

The module will be tested in collaboration with the University of Colorado's Kids as Global Scientists (KGS) program, which is exploring the potential for and the value of telecommunication networks within the science classroom. KGS already is engaged in detailed studies of student learning in projects that entail explorations and interpretations of professional-quality weather data. These are pioneering studies in respect to middle school students' understanding of weather phenomena (but with scientific rather than mathematical emphasis), and KGS is developing new models of collaborative learning. Through the Internet, students become "global scientists," expanding their understanding of local phenomena through exchanges with peers worldwide and through access to professional observing networks. The Skymath module will complement other parts of KGS, providing a math-focused element that enriches materials used by the teams of participating middle school math and science teachers and helps create an integrated science/math curriculum.

Development sites for the first Skymath module will be located in Colorado and Boston, Massachusetts. Activities and materials will be developed in a series of design, classroom testing, and revision cycles. A third party evaluation will be conducted by Insites, Inc. of Ft. Collins, Colorado, using qualitative and quantitative data. The evaluation will focus on student learning, teacher experience, the role of technology, and the value of using real-time data.

The Skymath handbook will be completed in 1997, and we are considering ways in which this module, in concert with the Blue Skies program, can be introduced into classrooms across the Nation. The 60 members of UCAR (all universities with strong programs in atmospheric or oceanic science) potentially can lead the way by introducing Skymath to preservice teachers during their science/math studies. The even larger number of colleges and universities that participate in UCAR's Unidata program could do the same, and many of these institutions play educational leadership roles in their respective states.

Our hopes extend well beyond the pilot module. Future Skymath activities will be targeted to diverse students, integrating their experiences, interests, and understandings. Our concept is to use science as a context in which to teach significant mathematics, bringing to light (for all students) the power of mathematics through a combination of math-focused, structured experiences combined with more open-ended exploratory experiences. We believe the mathematical content, teaching and learning derived from Skymath will instantiate the highest national standards.

The diversity of content and technology in the Skymath program illustrates the value of cooperative interaction between university departments of education, science, and mathematics and between university and school personnel. The Kids as Global Scientists program has shown that student learning is dramatically different when students can call on local professionals to help them develop expertise in a particular science content, and when students can expand their understanding of local phenomena through exchanges with peers in other locations. A particularly exciting outcome of KGS is that students who use the Internet to study science *demonstrate significantly better understanding of the subject content* than peers investigating the same phenomena under more traditional learning situations.

If preservice teachers were given the opportunity to use the wealth of materials available on the Internet (such as Blue Skies) during their academic studies, then they would be well prepared to take these materials into their own classrooms, and to assist less experienced teachers with technology implementation. Perhaps such experience could be made even more relevant by inviting middle-school teachers to participate in some of these university studies, giving the future teacher a realistic perspective on the obstacles and opportunities associated with these teaching and learning methods. Finally, we think there would be great value in creating support teams of teachers, university faculty and technicians to pave the way for new teachers and bring to reality the promise of Skymath.

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Interactive Mathematics Text Project

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"I hear and I forget.
I see and I remember.
I do and I understand."
(Chinese Proverb)

Using an interactive mathematics text students get a chance to "do" and "understand". The Interactive Mathematics Text Project (IMTP) was begun several years ago on the college level and was sponsored by the National Science Foundation and the Mathematical Association of America. The goal of this project was the improvement of mathematics learning through the use of computer based interactive texts. At sites throughout the United States professors worked together to develop sets of laboratory experiments in mathematics at the college level. The development tools that were used for these labs were Mathcad, Maple, Mathematica, and MathKit for Windows. Three years ago the project was extended to the high school level at six sites throughout the United States. The sites were Towson State University, Seattle Central Community College, University of Michigan - Dearborn, Los Angeles Pierce College, University of Houston - Downtown, and Morehouse College.

Why Do We Need Interactive Texts?

Why was there a need for a project like the Interactive Mathematics Text Project? Recently there has been concern over the level of mathematics ability and instruction throughout the United States. Our students do not compare favorably with students from other countries. Early in high school our students drop out of an academic mathematics sequence. By dropping out they are unprepared to pursue careers in science, mathematics, and technology. In an effort to reverse this trend, some attempts are being made to change mathematics instruction.

The National Council of Teachers of Mathematics supports the change from a passive way of teaching, in which the student is viewed as an empty container into which we pour information, to an active approach where the student learns by doing. The fundamental basis of the Interactive Mathematics Text Project is the belief that an interactive text can provide an environment in which students are actively involved and can explore mathematics with understanding. An interactive text engages students, encourages teamwork, stimulates creativity, extends and refines knowledge, and requires writing. In brief, it addresses all the concerns of the National Council of Teachers of Mathematics. Students solve problems by reasoning. They communicate their results and focus on solving problems, not on boring repetitive processes. The software removes that drudgery so that students can focus on real problems which make the connections to many other fields.

What is an Interactive Text?

An interactive text is a computer document within which symbolic, numerical, and graphic tools can be used. All computations can then be pasted into the document so that each learner has an individual record of his or her investigations and discoveries. Students can work through many examples because they can be created immediately with new numbers or new mathematical functions. Students can design their own graphic and calculational investigations with graphs and calculations showing when the student wants them. Students are using an electronic notebook in which they can ask the software for help as needed. Interactive texts can consist of a single module or an entire course in the form of a handbook.

Interactive Texts Engage Students

Students are required to explore mathematical ideas. The computer eliminates the boring labor necessitated by hand computations. Students working with an interactive text cannot be passive learners. They must master the concepts through their own efforts. Students gain ownership of a concept or relationship.

Interactive Texts Encourage Teamwork

Often interactive texts are used by groups of students in computer laboratories. The bantering of ideas with contributions from each member are a critical part of the learning process. Our society and its workplace require team efforts. Learning can no longer be a process in isolation.

Interactive Texts Stimulate Creativity

Our world today requires imaginative solutions to its problems. With an interactive text students can wonder what if, and explore their conjectures. The capabilities of the computer makes this possible.

Interactive Texts Help Students to Extend and Refine Knowledge

Because computation is so much easier, applications beyond the scope of traditional courses can be addressed. Mathematical modeling to its fullest extent can be applied. The problem can be translated into a mathematical model, the model can be solved, and the solution can be translated back to the problem. Interactive texts allow this to happen.

Interactive Texts Require Writing

The notebook interface permits and encourages the student to make notes in his or her copy of the text, i.e. an annotated text. Students can write comments and explanations. They must communicate the results of their efforts to others in writing.

Educational Implications : A Case Study

Objectives

The Parkville Center for Mathematics, Science, and Computer Science opened September, 1994, as a magnet school. The program began with eighty-one ninth grade students and in four years will include grades nine through twelve. The ninth grade students are taking algebra or probability/statistics and functions, geometry, chemistry, and computer science. The computer science class has introduced the students to various software packages such as Microsoft Works, Geometry Inventor, Algebra Explorer, Hypercard, and Mathcad. Interactive mathematics software has been developed in Mathcad. The purpose of the software is twofold: (a) to teach the students how to use Mathcad as a problem solving tool, and (b) to reinforce concepts taught in other magnet courses. The main objective of the interactive text is to engage the students into becoming active participants in the learning process. The students keep a daily log in computer science class.

Using the interactive texts will help to enable the students to become self-directed, life-long learners who will be competitive in a technological society. The students will explore the interdisciplinary connections among mathematics, science, and computer science to solve real-world problems. Students will conduct experiments and initiate research.

Audience

The students chose to attend the magnet school because of an interest and ability in mathematics, science, and/or computer science. To be selected into the program students must pass an entrance exam, be Algebra II ready, and have good grades and strong teacher recommendations.

Availability

Teaching in the magnet school computer lab is like teaching in heaven. The lab has twenty-eight networked 486 PC computers and each machine is licensed to use Mathcad. Mathcad was chosen as the mathematics software to use primarily because it is easy to use. In no time at all the students can be productive in solving a wide range of practical real-world mathematics problems. The students realize the power of Mathcad and seem to enjoy using it. Each student in the magnet program takes the computer science course and has available to them the interactive text via Mathcad. This is not the norm in most high schools throughout the country. Availability to the hardware and software necessary to operate the interactive texts is a major concern of the participants in the IMTP.

Cost

One of the main reasons for the lack of availability of necessary hardware and software is the cost. It is hoped that as the technology develops the costs will decrease.

Time factor

Unfortunately, there aren't a lot of teaching materials for using Mathcad on the high school level. Developing lessons on using Mathcad takes considerable thought and time. However, judged on student performance and reactions it is time well spent.

Teacher Use

One of the computer science teachers at the Parkville Center is learning how to use Mathcad along with the students. Again this takes a lot of time and extra work on his part. Time is required to learn the software as well as to plan for a changed style of instruction. The teacher is becoming a facilitator - a conductor of the mathematics orchestra composed of students, not a virtuoso whose mathematics is only heard by students.

Evaluation

The project is difficult to evaluate. Certainly, standardized tests and grades are measurable. The areas impossible to measure objectively are the students' attitudes about mathematics and the connections they make between mathematics and other fields.

Students Thoughts about Mathcad

The following is a sample of the impressions of the magnet students in regard to Mathcad:

We used the program Mathcad in class today. Its cool because you can do all kinds of equations and stuff and it will write the answer for you. I hope we use Mathcad a lot because it's neat, and will help when we have hard equations to solve. I hope we can print it out if we need to.

Today I worked with Mathcad. I find the program kinda interesting because it has so many options and stuff. I learned new things, too. I learned what these different math symbols mean, and stuff like that. Mathcad is easier to use than a calculator I think because you can see everything you have put in.

Today we used Mathcad to work out complicated math problems. It made solving them much easier. You simply entered the problem in and pressed <Enter> and poof!, the answer magically appeared on the screen! I wish we could use this for Statistics and Geometry.

Today I learned how to use the Mathcad program. It does lot of stuff that is very useful for a math program. We used the program to solve problems with exponents and parentheses. Then we learned how to use the math program to solve equations with variables. This was very interesting and we had to learn the syntax needed to get the computer to do what we wanted. Even when we learned how to use it, sometimes a misplaced finger on the keyboard could mess everything up so we had to be especially careful.

Today, using Mathcad, I learned a variety of new skills in the program. I learned how to use absolute values, square roots, iterated products, and summation calculations. We did several problems, and also learned to control the accuracy that the answer turned out. These skills were very useful for solving math problems. I also learned what a factorial is and what a summation is. Now that I know how to use Mathcad effectively, I wish that I had it on my home computer so that I could do my math homework on it!

I worked on units and dimensions in Mathcad and it is very interesting how you can change units very easily. I like how it is so very easy to use.

Today in computer science we worked with the Mathcad. I like working with the Mathcad because it does the work for you.

Today in computer science, we learned about the Mathcad program. It is a program that allows us to perform mathematical operations on the computer. We also learned how to enter in variables for equations. I know that the Mathcad is useful, but I have to say that it was just as fun as those spreadsheets we used to death.

Today I worked on a new program that was based on some math scratch paper and I have to say it was quite boring!

Today in computer science class we completed the solving equations worksheet. I like using Mathcad to solve these and the other math problems we have worked with because it makes it quicker and more fun.

Today in computer science we learned how to solve systems of equations by graphing. It was kind of fun but very confusing. Merideth helped me most of the time but I got the hang of it. I hope at some time we can use this program in algebra. It would make the problems so much easier.

Today in class we worked with Mathcad again. Mr. DeBlase thinks that it was pretty cool, in his own strange way, but we usually have differing opinions on everything. Even though it wasn't cool I'll admit it is a very useful tool to graph and to solve algebraic equations.

Today we worked with Mathcad again. We worked on the graphing problems we started last time. I also received new scatter plot problems. Mathcad has a lot of wonderful features that make doing graphs very easy.

Today we worked on solving systems of equations in Mathcad. The same thing we are doing in geometry, but made easier with the use of Mathcad. It cuts time and effort. Another discovery in the wonderful world of computers.

Probability and Statistics Handbook

At the Parkville Center this year, Sharon Wagner is teaching probability/statistics and functions. Vince DeBlase will be teaching computer science. Mr. DeBlase and Ms. Wagner collaborated (Interactive Mathematics Textbook Project at Towson State University, Summer 1994) to write twelve Mathcad interactive text labs for probability and statistics. The students will perform the labs in computer science class and in probability/statistics class. The purpose of the labs is to engage the students into becoming active participants in the learning process. The labs provide "engines" for exploring statistical concepts; i.e., the standard deviation calculator, Chebyshev's viewer, boxplot maker, binomial experiment calculator, correlation calculator, and the regression reporter. Simulations in probability can be done using the die roller, two dice roller, coin tosser, probability of same birthday simulator, and craps game simulator.

The labs are part of a Mathcad handbook. A Mathcad handbook is an Electronic Book. It comes with a table of contents and index. To navigate through the handbook, just double-click on entries in the table of contents, index, or in the chapters themselves. Mathcad also provides a toolbar palette to navigate the handbook.

The students can perform their work in an annotated handbook. The annotated handbook is a copy of the original handbook with the student's work saved in a different color. The original handbook is not changed. The teacher can then grade the annotated book.

Conclusion

The interactive text affects the learning process by engaging students, encouraging teamwork, stimulating creativity, requiring writing, and extending and refining knowledge. The teacher's role in the classroom is one of an advisor and an encourager. The student is an active participant making things happen. Teachers need to be trained to use mathematics software such as Mathcad in order to take advantage of a new and powerful tool in the learning process: the electronic text.

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Electronic Bulletin Board Systems (BBSs) and Student Teacher Education

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Today we see the advent of effective and increasingly inexpensive instructional delivery systems such as fibre optic transmission, compressed TV signals, and direct broadcast satellite programs. Parallel to this hi-tech world of sight and sound we also find an exploding populist movement of unprecedented proportions such that anyone with a $200 used computer and a modem can mine the Internet. This worldwide network provides both student and practicing teachers incredible access to information ranging from simple databases to complex arrays of graphics, pictures and sound. However, the growing potential of telecommunications, and our ability to communicate with one person or many persons at a distance—our telecommunications capability--seems to increase much, much faster than our will to develop, use and evaluate these remarkable new tools.

Teacher Education

We face severe challenges in our efforts to produce both adequate numbers and adequately trained teachers. Not only do low starting salaries and difficult working conditions face new teachers but we find that roughly one out of two persons who start teaching leave the profession after the first year. During this first year, the typical teacher will be anxious and lonely, presume that his or her problems are unique and the result of personal inadequacies, and feel financially oppressed as (s)he attempts to pay off college debts and live a middle class life. With few exceptions new teachers receive little if any help from a mentor (if one is even assigned) or from the school principal. As a matter of practice the brand new teacher is given the worse assignments in the school, frequently must teach subject matter for which (s)he is ill-prepared, and must handle classes of students that no one else can manage.

The challenge for advocates of telecommunications technology is to determine how and under what conditions our tools can be used to better prepare and support teachers. No one claims that technology should or can be used to resolve all of the issues we've mentioned. But, some of us feel that the systematic design and development of instruction coupled with effective use of communication tools can dramatically improve the quality of our teacher training programs and can be used to support new teachers especially in that critical first year or two of practice. The purpose of this paper is to consider how a telecommunication tool, the electronic bulletin board system (BBS), might enhance the education of student teachers.

Bulletin Board Systems

The name "bulletin board system" grew from a handful of folk in the early 1980's who were connecting computers together via 50 and 300 baud modems. One of the main attractions of these BBSs was the x-modem protocol, developed and provided as freeware by the BBS pioneer Ward Christensen, which allowed persons on BBSs to easily and reliably exchange computer files.

Today a BBS is defined as software which allows remote users to access a variety of electronic communication functions such as mail and conferences. Remote users typically use home or office computers with modems to dial over phone lines into a host computer. The host computer is the central access point where mail, files and other information is stored to be retrieved by the remote user.

In terms of access, we increasingly find that Local Area and Wide Area Networks (LANs and WANs) are tied to BBSs through routers and other means. In turn, increasing numbers of BBSs are part of a local, regional or international network. These networks range from populist endeavors such as FidoNet, a free international network of non-profit BBSs, to nodal access of information utilities such as America On-Line or CompuServe which require commercial contracts.

TeachNet

TeachNet is the name of the local electronic bulletin board system managed by the students and faculty of Instructional Technology in the College of Education at the University of Texas at Austin. TeachNet uses First-class software which provides graphical user interfaces for both Mac and Windows platforms. Other users can access TeachNet through a menu system. Physically, TeachNet consists of one Mac computer with a 500 mg hard drive, eight standard phone lines each with 14.4 baud modem, two Telnet lines and 20 local area network lines for users who are located in the College of Education.

A wide variety of functions are available on TeachNet which might be used by student teachers. These include:

- electronic mail which can be used between student and supervising faculty or between students who are working in different schools. E-mail consists of messages sent directly to an individual, much as letters are sent to individuals. The advantage of e-mail is that readers can read and leave mail 24 hours a day.
- conferences which are open forums for comment, debate and sharing. For example, students might leave one success story, per day, to focus on positive aspects of teaching. Or, individuals could pose a problem or ask for leads on resources to which other members can respond. Conferences as well as private mail can be used for logs or diary entries. A wide variety of conferences can be browsed for items of either personal or professional interest.
- computer files which represent a wide array of resources can be accessed and exchanged between participants. Such resources might include computer based instruction as well as utility programs, grade and report programs, etc.
- conferences and files can be searched by key terms to locate individual reports as well as teaching resources. For example, all social studies simulations suitable for fifth or sixth grade could be retrieved from a large file of computer based simulations.
- standard databases such as the UT catalog or a CD-ROM of educational games can be accessed by using TeachNet as a "door" to prepared databases. Also, such doors can be used to connect to international free networks such as FidoNet, to Internet, or to commercial information utilities such as American On-Line or CompuServe.

A BBS like TeachNet rapidly becomes a community resource where news, resources, friendship, gossip and support can be found. Users can dial in, communicate and be on their way much as one might run to the Commons for a cup of coffee, glance at newly posted bulletins, share a few bits of news with friends and then leave for daily work—except that TeachNet is available 24 hours a day.

TeachNet and Student Teachers

To encourage communication, a conference was provided for a group of 14 secondary mathematics student teachers housed at four different high schools. Two high school sites were provided with computer/modem access. All students had access to a computer and modem at home or at the school site. The students were requested to make critical incident reports at regular intervals, sharing both victories and frustrations in the classroom arena. Class information was also provided through TeachNet as was other pertinent information regarding job interviews, research suggestions, and mathematic puzzlers.

The Model

It is our contention that the BBS can aid the student teaching process through the development of teaching competencies. Seven general areas of competency for the student teacher have been culled from a standard student teacher evaluation form provided by the University of Texas at Austin. Most student teacher evaluations will look at these same areas: interpersonal relationships, application of subject matter knowledge, personal characteristics, skill in planning and organization, conducting instruction, assessment and evaluation, and classroom management. There exists certain functions within TeachNet which may assist in developing these attributes.

Interpersonal relationships include recognizing cultural differences, working cooperatively with others, expressing negative feelings without eliciting hostility, perceiving student feelings and listening carefully.

TeachNet provides opportunities for cooperative work. Assignments can be shared, passed between members for comment and contribution. Ideas can be expressed and developed with a democratic sense that often times is not shared via a face-to-face arrangement (Quinn, Mehan, Levin, & Black, 1983). The dualism of the permanence, yet translucence of the medium fosters a nurturing rather than confrontational situation.

The **application of subject matter knowledge** consists of:

(1) having sufficient background in the subject taught,
(2) understanding the fundamental structure of the subject,
(3) presenting content at an appropriate level of difficulty,
(4) being able to answer students' questions correctly,
(5) including stimulating tasks.

TeachNet allows rapid asynchronous transfer of lesson plans. Search capabilities can enable the student teacher direct assess to a group database. Questions can be raised and addressed within a non-threatening peer situation. Ideas can be tried out with the group before a class session. Each student teacher's creativity quotient is raised by the number of members in the group as everyone can contribute.

Personal characteristics are attributes such as effort, enthusiasm and initiative which enable a student teacher to do a good job .

TeachNet can help develop and maintain enthusiasm through the peer sharing/collegial aspect of the BBS. The electronic medium is felt to be different than both regular written communication and face-to-face speech, providing a more active and involved interaction between individuals (Hiltz, 1986). The electronic medium provides both a relaxation of the formality of the written word and the development of the urgency of oral discourse (Grabowski, Pusch, and Pusch, 1990). These unique facets of electronic discourse may also develop more challenging forms of writing (Downing et al, 1988).

Skill in planning and organization is another area to be developed in student teachers. Being able to plan for long term as well as short term goals is very important, as is being able to state objectives clearly and to create sequential learning opportunities.

Lesson sharing provides an opportunity for the development of student objectives. Quite often it is easier to see and understand the structure of another's work rather than one's own. Tasks which deliberately foster structure and direction can be developed via TeachNet.

The ability to **conduct instruction** is of major importance for student teachers. Communicating to students the purpose and procedure for lessons, giving directions clearly, and adjusting and adapting the presentation to meet the needs of students are all important aspects of conducting instruction. Student teachers should also develop a wide variety of cognitive levels within the student group.

As we share with our peers it is quite often that we find the fuzziness of our own thinking, forcing us to take deliberate steps in order to be clear and direct. TeachNet promotes that clarity. The conference may provide the proper feedback as to the level of questioning occurring within a lesson. Peers can offer insight and direction as to what has and has not worked with them.

The **assessment and evaluation** phase of teaching is also critical to the development of the student teacher. Can the student teacher assess the students' knowledge? their skills and interests? Can the student teacher identify students for possible remedial help? Is assessment information used in planning? Can students become involved in self evaluation?

A database of assessment tools may be created which can be disseminated through TeachNet. Diagnostic techniques, methods of assessment, and even test questions can be shared.

And of course, the most talked about aspect of teacher training, **classroom management**, is necessary for many of the other goals of teaching to occur. Has the student teacher created a "learning environment"? Are there standards of organization which aid the creation of that environment? Is time wisely spent? Answering these questions in the affirmative is vital to become a teacher who can contribute to student growth.

The critical incident reports may become the most likely forum for sharing techniques that work in the classroom. As a development tool, student teachers can observe how peers meet a trying situation and come to grips with the same problems that each of them might one day experience. The shared nightmare becomes much less frightening when faced together.

The NTCM Standards and the BBS

The National Council of Teachers of Mathematics has provided a list of professional standards which are to guide the teacher in developing a mathematically literate student. These are grouped into four goal categories: (1) to undertake worthwhile mathematical tasks, (2) to establish and develop mathematical discourse, (3) to create, nurture, and sustain a learning environment, and (4) to analyze the teaching and learning process. Achievement of these goals is greatly facilitated through the use of an electronic bulletin board.

Tasks

How can the BBS enrich the content of the mathematics curriculum and provide worthwhile mathematical tasks? Our study has found student teachers will explore mathematical problem solving and share suggestions for curricular direction within TeachNet. For example, they can post and share entire lesson plans.

Discourse

The student teacher is both teacher and student; consequently, he or she must assume both roles in the course of his or her development. Our group has discussed on-line: guns in the classroom, the class that runs amok, and students who are less than enthusiastic about learning. The ability to thoughtfully listen and empathize is of vital importance to the development of the student teacher. Exposure to peers dealing with such sensitive issues is facilitated by the BBS.

The BBS allows the moderator to perform certain aspects of guidance as are suggested by the standards. We've attempted to encourage each student teacher to participate. We've also posed questions with the aim of evoking, engaging, and challenging each student teacher's thinking.

A stated goal of the standards is the encouragement of the use of technology in enhancing mathematical discourse. The BBS is such a use as the need for discussion of critical issues grows daily.

Learning Environment

Perhaps the most valuable aspect of the BBS is that it can create a stable, nurturing learning environment. A deliberate attempt by all participants to respect and value each others ideas and viewpoints is evident. Our series of seemingly simple but quite complex math problems (e.g., the chicken who lays eggs at a rather peculiar rate) has caused some students to post the wrong answer. (It isn't often that a bunch of math teachers will have the wrong answer.) The environment to explore and venture a solution, even though incorrect, is well worth pursuing.

Analysis of Teaching

The BBS offers the possibility to make plans, both short and long term, with greater ease than other methods. It allows student teachers to describe their learning to each other and to comment on what they have seen. We began with a simple critical incident report. A student teacher was to post a good idea that he or she observed in class. These reports became a casebook of superior teaching methods to which all student teachers had access.

Conclusion

Certain aspects of the BBS forum need be discussed within a social construction of knowledge framework. If meaning is created through a shared experience between two or more people (Vygotsky, 1978), then the collaborative approach of the BBS engenders a rich learning environment. Others have shown the collaborative effects of the BBS through problem-solving exercises (Scott, 1993), through writing projects (Balester, 1992), and through social environments (Kaye, 1989). Real time synchronous conferencing, electronic mail, and text sharing all contribute to a vibrant collaborative effort.

Electronic teams may be created in which student teachers can devise strategies for teaching mathematical principles and improve their own math skills. Leadership teams and publishing teams have also been shown to coalesce on a BBS with the proper guidance (Wilsman, 1988).

Student teachers, once established on the school site, have very little opportunity to engage in regular, organized discussion with university supervisors. Communication through the BBS provides effective information sharing and increases the efficiency of the transfer of ideas dramatically. Managerial functions are better handled through precise record sharing and monitoring. Flowcharts, calendars, and other graphical organizers may also be posted to the BBS.

The BBS functions as a shared log or diary. The very act of committing to text our thoughts and ideas elevates them to a higher platform (Hays et al, 1983). The BBS promotes and encourages the written word as the major form of discourse and promotes a focus on feelings as well as ideas.

Finally, record keeping of projects, ideas, areas of agreement and disagreement, and the entire phenomenon of the student teaching experience as perceived by the participants is recorded. This experience can be downloaded and stored to be accessed again and again. All too often, memory is lost in any endeavor, particularly those memories that are personal and filled with emotion. A BBS encapsulates the experience.

We've just begun to tap the potential for using a BBS to aid in the development of student teachers. There is a certain separateness, even a loneliness about the student teacher training period. The BBS can cut through that isolation and involve the student teacher with both his peers and the university staff. The BBS can foster teamwork and collaborative effort; it provides a tool to facilitate the growth necessary to become a good teacher.

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Teaching A Computer Notation for Secondary Mathematics

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Mathematical notation should help make underlying notions clear. Unfortunately, ambiguities and inconsistencies in conventional notation appear to make learning mathematics difficult (Peelle, 1989). For instance, in elementary arithmetic, multiplication is denoted in several different ways: axb, ab, (a)(b), axb, xa b, and a*b. Different symbols are also used for division: ÷ / - ⟌ . The equal sign is used for several different purposes: assignment (x=3), equations (x^2-5x+6=0), identities ($\sin^2$x+$\cos^2$x=1), comparisons (is x=3?) and predicates (if x=3 then ...). Many fundamental mathematical functions don't use symbols at all: exponentiation, logarithm, remainder, sine, cosine, etc. Furthermore, function syntax is unsystematic: input can be on the right (as in -x), or the left (x!), or in the middle (|x|) and use superscripts (x^n) or subscripts ($\log_x$n) or both (as in sigma notation for summation). See Iverson (1980) for extensive discussion of how notation can be unified.

Mathematical notation is evolving (McIntyre, 1991). Indeed, a transition to computer-executable notation seems to be occurring. It began when a mathematical notation (called APL) was designed to be simple, uniform, general, and practical for interacting with computers (Falkoff & Iverson, 1973). APL has been used for several decades world-wide, particularly as a programming language for scientific and business applications (*APL Quote-Quad*).

Now there is J — a new computer notation, derived from APL, which is well-suited for teaching mathematics (Iverson, 1994). This paper describes a teacher-education course which introduces J to math teachers.

Teacher-Education Course

"Teaching Mathematics with Computing" is the current title of a course which has been offered experimentally at the University of Massachusetts' School of Education for several years. The course meets 2.5 hours per week for 15 weeks in a semester. Enrollment is typically 10 to 15 graduate students, including in-service teachers of mathematics at all levels. Most have had some previous computer experience, but not many have done much programming, and only a few know more than one programming language.

The course emphasizes teaching secondary mathematics and presumes knowledge of relevant curriculum but does not require "computer literacy". It does provide an opportunity to learn some programming although that is not the expressed purpose. Rather, the course focuses on how to utilize and integrate computing — not computers, per se — in teaching mathematics. Accordingly, there is no attempt to cover math courseware/software. J is used as a mathematical notation in the course, and other programming languages (such as BASIC, Logo, Pascal, and Mathematica) are welcomed for comparison.

The course is comprised of a series of workshops, coupled with discussion reviews every week. Each workshop is conducted in a computer laboratory currently equipped with nine QuadraPro microcomputers (Macintosh with MSDOS 486 card), running J version 7.0 freeware (Iverson, 1994) with or without Windows. A typical workshop lasts about 1.5 hours.

A review of each workshop occurs the week afterwards in a seminar classroom for about one hour immediately preceding the next workshop. Discussion includes: analysis and history of notation; technical questions about J; alternative algorithms and related mathematical topics; appropriate teaching techniques; conceptual bugs and different learning styles; pedagogical issues; and implications for math education reform. Discussion stimulates possible topics for a required termpaper, which is presented in the last class.

The workshops are designed to be somewhat independent, flexible and transportable to other educational settings such as conferences and in-service professional development. The overall pedagogical approach is "constructionist" (Harel and Papert, 1991), guiding participants toward building working programs as well as their own conceptual models. See Peelle (1993b, 1994a) for details of workshop design.

A booklet (Peelle, 1994b) is distributed at the beginning of the course. Actually, each person is given two copies — one to use for handing in weekly assigned worksheets, and one to keep for reference. The instructor reviews completed worksheets, writes comments, and returns them the following week.

The booklet contains: a description of the workshop design; worksheets for each topic (listed below); discussion of several sample topics, including suggestions for teaching; a dozen or so simple problems and programming projects plus solutions; summaries of introductory J, math topics, and teaching techniques; references and follow-up sources.

The workshop topics are:

1. Averaging
2. Gauss's Formula
3. Pascal's Triangle
4. Pythagorean Theorem
5. Divisors
6. Function Tables
7. Primes
8. Logic
9. Sets
10. Sorting
11. Fibonacci Sequence
12. Polynomials
13. Probability
14. Statistics

Workshops

Each workshop is based on a worksheet (typically one or two pages) with the following instructions at the top:

Examine the following J expressions and write annotations on this page (and back, if needed) briefly describing what you think each expression does.

As you proceed, use the computer to explore behavior of new symbols by trying additional similar expressions. Observe patterns in the results and try to infer how the symbols work in general.

Review the overall sequence of expressions given and identify the algorithm or topic illustrated here. If possible, embody the algorithm in a program, modify it for your own purposes, and explore related topics.

The first workshop is described below; the next few are sketched (due to space limitations here). Full descriptions are available from the author.

1. Averaging

This familiar topic is offered first because teachers are expected to know how to average numbers and hence won't have to learn a new concept or algorithm — only how to get started using J.

To begin with, everyone enters this expression:

```
   N =: 85 65 90 95 80
```

The name N is intended to stand for "numbers". Most teachers soon realize that any (longer, more descriptive) name may be used and that the numbers are arbitrary (here, representing exam grades). They grasp the important concept that N is a variable (called a "pronoun" in J) and that =: means assign a name to the numbers temporarily (just as a pronoun assigns a name temporarily to a noun). The notation =: can be read simply as "is". So, the above expression reads "N is (five numbers)".

Some teachers are not accustomed to seeing a variable assigned several numbers (with a space required between each number). Such a list is one kind of "array", the fundamental data structure in J, which is treated as a whole entity. Here, N is a one-dimensional array. Later, they will encounter a two-dimensional table (or "matrix") and perhaps 3-D and higher dimensional arrays.

The next expression introduces a function:

```
   #N
5
```

It is readily apparent that # (called Tally) counts how many numbers are in the list N. The computer prints the result (5) at the left margin, whereas the expression is indented. Most teachers learn this convention quickly; it seems to help actualize the concept of a function (also called a "verb" in J) which performs an action; that is, it has an input, does something to it, and produces an output.

J offers more than one hundred such primitive functions on the keyboard. At this early point, however, it is rare that someone explores applying this function (or other functions) to other inputs, even though it is explicitly encouraged and could well reinforce learning properties of variables and functions. Most teachers seem content to follow the worksheet.

Next, another function is applied to N:

```
   +/N
415
```

The function +/ (called Sum) calculates the sum of the numbers given. Hardly anyone has difficulty with this new notation even though the / symbol is dissonant with its common use for division. Hardly anyone asks how +/ actually works either, but a brief explication is worthwhile: / is actually an "adverb" (called Insert) which modifies + (Plus) to produce a new function +/ (called Sum) — in effect, inserting + between the numbers. / can be used with other functions such as * (Times) to produce */ (called Product). Teachers usually accept all this superficially as the way J does such things. A few explore / with other non-associative functions such as - (Minus), which raises the issue of exactly how J evaluates expressions and is best deferred until the second workshop.

The next expression is the algorithm for averaging numbers. Everyone recognizes it: sum the numbers and divide by the number of numbers:

```
(+/N) % (#N)
83
```

The % symbol is used for division because it looks most like the traditional symbol ÷ (which is not on standard keyboards). Parentheses are used in the normal way to indicate which parts of the expression are done first. The result is printed out automatically.

Most teachers appreciate how averaging numbers can be done so succinctly in J — especially compared to awkward and lengthy programs required by other programming languages.

In order to try this algorithm again, the next expression includes an additional number in N:

```
N =: N , 89
```

Teachers easily understand that this replaces what was in N with a new list, noting that entering just N,89 would not change N. This strengthens the concept of variable. But they gloss over the use of , (called Append-Items) which is a function for joining items together. Perhaps this is because of the traditional use of comma for separating groups of three digits in a large number such as 1,000,000 (which J represents simply as 1000000).

The next entry is N, which prints the list created above. (Many teachers expect to use a PRINT command, which is not needed in J.) Now one can see that the 89 has been joined to the end of the list:

```
N
85 65 90 95 80 89
```

The next three expressions are the same as earlier. Count the numbers in N now:

```
#N
6
```

Compute the new sum:

```
+/N
504
```

Average the (six) numbers:

```
(+/N) % (#N)
84
```

Some teachers are more comfortable assigning names to the intermediate results, which presents the algorithm vertically in steps (not shown on the worksheet) instead of horizontally in a single expression (as shown here). J permits both programming styles and also facilitates "functional programming", as indicated by the next expression:

```
(+/ % #) N
84
```

This illustrates how three functions can be composed and applied as a single function. This composition (called a "fork") has a function in the center (here %) which uses as its two inputs the result of the function on its left (+/) and the result of the function on its right (#). In other words, when applied to N, this becomes: the Sum of N Divided by the Tally of N. Since a fork is a new syntactical structure, teachers need ample time to get used to it. Accordingly, this and the next several worksheets include many opportunities for practice.

A composed function can be given a name, such as the following abbreviation for 'average':

```
ave =: +/ % #
```

This effectively defines a program without explicit use of variables (as in pure functional programming in computer science).

Entering the name of the program displays its definition:

```
ave
┌─────┬─┬─┐
│┌─┬─┐│%│#│
││+│/││ │ │
│└─┴─┘│ │ │
└─────┴─┴─┘
```

Teachers like this visual representation of a program with a box around each component. Here it shows the structure of a fork with a box around the three main functions, as well as boxes around both symbols in +/ since + is itself a function (verb) and / is an adverb. Studying this display makes the algorithm clear functionally: Sum Divide Tally, where Sum is Plus-Insert.

The next stage is to test the program, which requires an input (on the right) as shown:

```
ave N
84
```

An analogy helps here: first teach the computer how to do something, then tell the computer to actually do it. Furthermore, it is important to realize that the program behaves like other functions and can be used with different inputs. For example:

```
ave 2 4 6 8
5
```

Now it becomes clear that this program computes the average of any list of numbers. Teachers demonstrate this for themselves by entering numbers of their own choice. (Decimal numbers are represented in the normal way, as in 0.5; negative numbers, as in _4; large numbers in scientific notation, as in 1e6 for one million.) Special cases, such as a single number, an empty list, a table or higher dimensional array, and complex numbers are deferred until later — but will work correctly.

A program such as this is valuable not only for its own use but as a tool for building additional programs. For instance, the algorithm developed here (formally the "arithmetic mean") can be easily modified to compute the "geometric mean" (nth root of the product of a list of numbers). Also, the mean leads to more topics in statistics such as median, mode, histogram, standard deviation, correlation, etc. — which are broached in workshop 14. Also see Chapter 11 in Peelle (1986).

At the end of this first workshop, teachers can begin to appreciate the advantage of having a program (and not having to retype expressions). Indeed, some want to know how to save and retrieve programs. So, fundamentals of computer system management are shown to those individuals during the workshop and eventually to all in subsequent review discussions.

Averaging occurs in many everyday applications such as monthly rainfall, sports statistics, expected travel time, weighted quiz scores, etc. At the end of the workshop, it is worth discussing how each teacher might conduct lessons with their own students using J for teaching averaging and other related topics.

In summary, this workshop helps teachers get started learning a new computer notation by rediscovering how to average numbers in J, by representing the algorithm clearly and concisely in a mathematical notation executable by computer, and by constructing a program for experimentation and use as a tool for studying additional topics.

2. Gauss's Formula

The second workshop presents three different algorithms for summing consecutive positive integers. The first is a direct expression +/I where I is a list of positive integers from 1 to I assigned as I =: >: i.N (I is Increment of Integers 0 to N-1). Teachers experiment with the primitive functions >: (Increment) and i. (Integers) individually. Since these functions are used together (without parentheses), this is also an opportunity to introduce J's rule for order of operations: "Every function uses the result of the entire expression on its right". Here, the function >: uses the result of i.N — effectively adding one to each number in the list of integers from 0 to N-1. This is not problematic for teachers since this rule amounts to doing the rightmost function first, as in f(g(x)), which is the convention in mathematics.

The second algorithm is (+/I+|.I)%2 which is evaluated as (+/(I+(|.I)))%2 — (the Sum of I Plus Reverse of I) divided by 2. This presents another opportunity to scrutinize J syntax. A simpler example helps confirm that J's rule is consistent: 4*2+3 is the same as 4*(2+3) in J (because the rightmost function is done first anyway) and could just as well be written as (2+3)*4 — but not 2+3*4. Although J's rule is completely general, governs all functions equally, and allows unlimited choice of functions in an expression, it is controversial. Teachers have a hard time unlearning the traditional hierarchy (exponentiation before multiplication and division before addition and subtraction) even though its inadequacy can be exposed: What is the value of 2*3/4*5? What is 10 raised to the 2 raised to the 3 power? When using log and sin and factorial and summation (without parentheses), which are done first? And, can students remember a hierarchy of more than a few functions? It seems that J's single, simple rule would be easier to learn. In contrast, many teachers complain that the rule is different from standard mathematics and do not expect that it could be introduced in math education today. Nevertheless, this issue can be defused by using redundant parentheses (as done in these workshops) in the early stages of learning J.

The third is the well-known formula N*(N+1)%2 attributed to Karl Friedrich Gauss in the late 18th century. Teachers are encouraged to give this formula a name and to study related topics further by using a program, which leads to generating a list of "triangular numbers". See Peelle (1993a) for full description of this workshop.

3. Pascal's Triangle

The next workshop introduces an unfamiliar algorithm for producing successive rows of Pascal's triangle: r =: 1 then r =: (0,r) + (r,0) generates the next row by appending a 0 to the front and back of r and adding the two lists in parallel. Teachers absorb this with some hesitation at first since they are used to generating such numbers one at a time but then soon recognize a whole row as coefficients of the binomial expansion. Some also connect results to the topic of combinations. In any case, this algorithm is embodied in a program, called pascal, which can be iterated using ^: as in pascal^:(4) 1 for the fourth row and pascal^:(i.5) 1 for the first five rows. Other ways to produce Pascal's Triangle arise in later workshops.

4. Pythagorean Theorem

This workshop involves Pythagorus's famous theorem ($a^2+b^2=c^2$ for a right triangle) to derive a program for distance between two points on a Cartesian plane. First, the points are entered as variables, and the algorithm is developed step by step. The same computation is then done in one expression without unnecessary variables. Then it is recast using J's handy primitives *: (Square) and %: (Square Root). Finally a program is defined: distance =: %: @ (+/) @ *: @ (]-[) which is read "distance is Square Root of Sum of Square of Left input Minus Right input". It is used with two inputs lists of (x,y) coordinates, as in 4 6 distance 7 2, which yields 5. Several more examples are shown, including three numbers on the left and right, representing two points in 3-D. Teachers test the program further, which is already generalized to compute distances in n-space.

Follow-Up

All teachers in this course keep a journal recording their experiences of learning a new language which, upon reflection, can help them understand what it's like for their students to learn the language of mathematics.

Many teachers engage in extra activities beyond the course requirements. For instance, some continue to learn more about J on their own (via independent study for credit); some tackle programming projects; some write comparative programs in other languages; some try using J in their classrooms; some develop sample curriculum lessons; and some conduct surveys. Results generally encourage further experimentation with J as a computer notation for teaching secondary mathematics.

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IT and Mathematics Teaching: New Roles for Teachers and Implications for Training

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Information technology (IT) for education remained a lab product until the beginning of the 1980s when its introduction into school practice became possible due to availability of low-cost technology. Initially, IT experiments were carried out by small groups of researchers and a few teachers. The work provided evidence of the educational potential of IT.

Very little teacher training was initially provided but external stimuli led an increasing number of teachers to develop and use activities involving IT. Some of the activities proved to be very effective and encouraged teachers to continue to experiment, but all too often computers were employed "for the sake of using computers" rather than for educational benefits. Often computers were employed when, from an educational point of view, better results could be achieved through other means, and they were not used when they could have efficiently and effectively contributed to the introduction of new topics or further development of topics already covered.

It has been acknowledged that many of the inappropriate uses of IT in schools are the result of a lack of preparation and training for teachers (Bigum, 1990; Rogers, Moursound, & Engel, 1984). Consequently, much work has been done in this direction. However, training which addresses the cultural interests of teachers and their students and which provides an adequate background for giving teachers autonomy with IT are not yet well defined. In addition, rethinking appropriate uses for IT is particularly difficult in areas such as mathematics education where a long tradition of IT use already exists.

Teachers' autonomy has a growing importance because of expectations derived from recent advances in technology, i.e. multimedia, virtual reality, electronic networks, which seem to offer rich new possibilities for education (AA.VV,1987; Bates, 1994; Krueger, 1991; Roberts, Blakeslee, Brown, & Lenk, 1990). IT training that introduces teachers to the most current technologies and instructional strategies for use with those technologies is needed.

In accordance with these ideas, our paper focuses on training strategies which guide teachers to experiment with IT on the basis of their own experiences and culture. Starting from the analysis of teachers' needs, we shall discuss the objectives that, in our opinion, should guide a training project. We will outline content and proven methods for reaching such objectives and will refer to training experiences that we carried out in the area of mathematics education.

Inserting New Technology in the Scholastic Practice

Both external and internal motivations stimulate teachers to insert new technology in the scholastic practice. External motivations that encourage the progressive use of information technology in our society include the new structure of the job world and the interests of students who consider technology an everyday tool and seek up-to-date schools. As for internal motivations, it must be noted that research only recently has begun to provide evidence of the educational potential of new technology. Moreover, several experiences pointed out that informatics, the main scientific basis of IT, is a powerful formative tool which can be fruitfully employed to give students the capability of organizing knowledge and structuring reasoning.

Consequently, teachers should enrich their knowledge according to the following. They should know, at least from a general point of view, how technology affects job organization; they should be aware of the kind of basic culture which should be given to students to facilitate their insertion into the job world. Moreover, teachers should add to their technical competency the capability of using technology to guide students to organize their knowledge and to structure their reasoning. Finally, teachers should learn how to organize resources of technology, i.e., speed, computation, multiple representations of knowledge, multimedia, distance communication in order to improve their teaching.

To acquire these kinds of competencies, teachers must recognize and address several difficulties. First, there is the psychological difficulty caused by the gap between their preparation and the students' expectations. Second, there are limited numbers of prepared and tested educational IT materials for classroom use. This is particularly true in countries such as Italy where the majority of literature is written in a foreign language. Finally, teachers are scarcely supported by scholastic institutions. With little assistance, they must make decisions about technological tools for classroom use.

These considerations highlight the need for teacher training to be framed in a more general context of a new kind of ability which is needed by teachers in order to make education benefit from technology.

Training Teachers in IT

The effective use of IT in education requires inservice teachers to change their roles. They must acquire knowledge about new resources at their disposal in order to recognize opportunities which IT offers to stimulate learning. Moreover, they must modify their teaching methods in order to take advantage of this new occasion of cognitive growth. The change is possible if teachers are trained to do the following.

1) Explore standard educational situations to determine which types of tools can increase the quality of teaching and learning.
2) Investigate if and how the use of IT can favor the introduction of subjects not usually present in teaching programs but fundamentally important in education.
3) Critically analyze an IT tool in order to define the most appropriate use for it in specific educational situations.
4) Fully understand what kinds of tools can increase the quality of teaching and understanding.
5) Give operative indications for integrating technology into the scholastic practice.

These kinds of abilities are not acquired within a course of a few weeks unless training has been carefully organized. With these ideas in mind, we have organized and presented several courses over the last 10 years. The remainder of the paper briefly outlines our work. We will start from our first experience, which dates back to 1982 (Forcheri & Molfino, 1986), because it remains, in our opinion, valid also today from a pedagogical point of view. We will point out the advantages and main limitations of our choices, and we will describe the work we carried out subsequently in order to improve our training activity.

The First Experience

The first experience refers to a training course which was carried out for two subsequent years, 1982 and 1983. The course was inserted in a National Summer School on Computers and Education supported by the National Research Council (NRC) and the University of Lecce. In both years about 50 teachers of various scholastic disciplines followed the course.

One of the main aims of the course was to teach teachers to analyse educational situations in order to find out what kinds of technological tools could be used to improve the learning process. In particular, we discussed various examples in which the use of software packages is especially effective to illustrate topics, to explore, or to solve problems. Moreover, we gave practical examples and indications leading to the characterization of educational situations where it is significant to use computers, pointing out the advantages and disadvantages which may derive. The course was organized in the following way: theory lessons (9 hours); practice in the computer lab (20 hours); and development of an educational project (22 hours). In both years we supplied teachers with worksheets, papers and documentation on the software analysed, software material, and bibliography.

Several positive aspects of the experience include the following: (a) teachers were involved in the development of an educational project; (b) teachers were allowed to choose projects according to their cultural interests; (c) much of the training was spent in the computer lab; (d) the emphasis was on the integration of technology in teaching rather than on technology "tout court"; and (e) the high rate of lecturer to participants.

In particular, the experience led us to believe that training courses on IT which give rise to positive modifications in the scholastic routine should do the following things.

1) Give a common background in IT to allow participants to face practical problems in IT;
2) Carry out an operative analysis of the topics covered in the theory lessons to allow self-control of the quality of understanding;
3) Offer a high lecturer/participants ratio and assign students to carry out activities in small groups;
4) Propose the development of a small educational project to act as a stimulus for classwork and encourage teachers to make proposals of integration of IT in the didactic practice;

5) Focus attention on only a few topics and analyze them in depth. The rest can be mentioned briefly and postponed to following courses or to the bibliography;
6) Consider the different interests and cultural background of participants in the course by asking them to choose among different proposals.

These considerations formed the pedagogical basis of our subsequent work.

The Evolution

The 1982-83 experience highlighted above shares the positive aspects of our choices but does not reveal the limitations. In particular, this kind of organization is very expensive with regard to the economic aspects as well as the organizational effort and the application required by the participants. Moreover, the episodic nature of the course does not force us to face the problem of keeping teachers constantly informed and renewing their knowledge. Such a problem is particularly delicate in the case of technology due to its continuous evolution and to the rapid diffusion of educational tools. Finally, it must be pointed out that, at present, a basic culture about technology is quite diffused among teachers. Thus it is possible to differentiate the training on technology according to specific scholastic topics (Forcheri & Molfino, 1992; Bottino, Forcheri, Furinghetti, & Molfino, 1993). As a consequence, in our further training experiences we maintained the 1982-83 pedagogical line, but we changed organization and, of course, we updated content.

More precisely, the work we carried out led us to individualize several organizational factors which, in our opinion, greatly helped to make our training more effective. The most significant factors are as follows.

1) Organized courses via a cooperation between scholastic and research institutions in order to reduce costs, reach a larger audience, and give teachers an institutional reference point. Examples in this direction are the training courses we organized in collaboration with I.R.R.S.A.E. Liguria (Regional Research Institute for Educational Experimentation and Training) in 1987-1991. These courses were designed for mathematics teachers. About 100 teachers participated in each course. The courses were aimed at helping teachers to build educational units which integrate technology in mathematics teaching (Forcheri, Furinghetti & Molfino 1991).
2) Involved experienced teachers as lecturers in order to give participants concrete examples of educational experiments with IT and reduce their psychological distrust. An example is constituted by a course we organized in collaboration with I.R.R.S.A.E. Liguria in 1991. The course for mathematics teachers was aimed at diffusing negative beliefs and experiences and providing opportunities for positive experiences. Consequently, it was decided to choose as lecturers mathematics teachers with previous IT experience in classroom practice.
3) Organized courses locally in order to give teachers the possibility of a durable and profitable link with the lecturers. For example, the course cited above was repeated in several scholastic districts for a total of about 500 participants.
4) Provided continuous training to go in depth on some specific topics of interest. Accordingly, we gave a series of lectures on new products or new teaching ideas. The audience for these lectures were usually mathematics teachers who previously had received a basic IT training course.
5) Addressed the course to a particular "category" of teachers (mathematics, physics, history, mother language, etc. teachers) in order to link technology to the renewing of the teaching of the discipline. An example is a course presently carried out by the GREMG group (Group of Mathematics Research and Experience of Genoa), in which we participate. The course aims at making teachers rethink mathematics teaching while taking into account new ideas on mathematics learning and the new possibilities offered by technology. The course is articulated in 7 months and lasts two scholastic years (6 hours per month). The main objective of the course is for working groups to develop didactic units for the classroom. Such units refer to educational use of advanced tools such as symbolic manipulators or of everyday applications such as spreadsheets.
6) Provided a public lab where teachers could experiment on their own with new technology after the training course. A laboratory equipped with 10 Macintosh computers and a multimedia station was provided at IMA-CNR (Institute for Applied Mathematics of the National Research Council of Italy). This lab was used by teachers who intended to experiment in their classrooms with the assistance and collaboration of IMA researchers.
7) Organized forums periodically in order to keep teachers aware both of changes in technology and of the evolution of cognitive ideas. Once a year, we organize a workshop or a national conference on technology in education in Genoa. Examples include Didamatica '93 (Andronico, Forcheri, Molfino, Pedemonte, & Sacerdoti, 1993) and the workshop Logic Programming in Education 1994 (Bottino, Forcheri & Molfino, 1994). These initiatives are usually followed with interest by teachers and constitute a good occasion for exchanging experiences.
8) Provided a public library on educational technology. The Educational Software Library (BSD) of ITD-CNR (Institute of Educational Technology of the National Research Council of Italy) houses a specific documentation centre for public consultation. BSD, moreover, periodically organizes lectures to present new products and to discuss new proposals. Lectures are usually organized according to various scholastic topics. For example, we usually give the lectures on tools for mathematics teaching. This kind of initiative constitutes, in some sense, a form of continuous training.

Conclusion

It is generally acknowledged that the change of teachers' roles is the crucial requisite to make schools take advantage of IT. With respect to this problem, several questions are open. How do we motivate teachers to change? What factors prevent teachers from changing? What kind of innovation should be introduced in teachers' preparation? How shall we encourage teachers to have a critical approach to IT?

In our paper we have tried to give a partial answer to these questions. The ideas outlined have been implemented to verify their validity, and the results obtained are encouraging. In particular, we ask teachers to take into account the potentiality of technology and rethink their teaching subject as we frame the IT training in their specific teaching area.

As a result, experiments on IT are effective and integrated in the curriculum.

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A Framework for Reporting Performance on Problem-Solving Assessments: SPP Charts and Classroom Applications

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Many teacher educators and educational measurement specialists recognize that assessment needs to move from a task-based focus to a theory-based focus (Baker, O'Neil & Linn, 1993; Harnisch, 1994; Mislevy, 1993; Popham, 1993). Leaders of curriculum reform in subject areas have advocated development and assessment of generalizable aspects of learning and performance (National Council for Teachers of Mathematics, 1989; National Research Council, 1993). Areas often cited include higher-order thinking, content related knowledge and skills, applying rules and understanding relations, problem-solving, reasoning, and deep understanding. The efforts of developers of performance-based assessments have generated many intuitively appealing tasks, but rarely link to the cognitive constructs being promoted and measured. Many researchers document the failure of recent performance assessments to generate reliable estimates of a student's ability to engage in generalizable cognitive construct activities within and across subject matter domains (1991; Harnisch & Mabry, 1993; Linn, Baker, & Dunbar, 1991; Shavelson, Baxter, & Gao, 1993). This may be due in part to unclear conceptions of what is being measured. Theory-based frameworks are needed to bridge the gap between performance assessments tasks and what the tasks are measuring.

Popham (1993) states that any framework that attempts to articulate generalizable cognitive components of performance should be general enough to apply across subject-matter domains, yet be specific enough to permit practicing teachers to capture the generalizable aspects of performance in the context of different content using multiple assessment strategies. This theory-based framework permits examination of patterns of performance (of individuals or groups of students) across multiple measures of important cognitive components of the more global construct of problem solving. Diagnosis of response patterns is an important part of teaching. Such analysis of response patterns is motivated by the belief that additional instructional information is contained in the analysis of the errors student make in responding to test items (Harnisch & Connell, 1990).

This paper will present a method of organizing, analyzing, and reporting of test results useful to a classroom teacher. Teachers spend much class time on testing. One study of tenth grade math teachers reported that 12% of class time is used for testing (Dorr-Bremme and Herman, 1986). This testing time was broken down into several types: state required testing (9%), district-required testing (14%), and teacher-made tests (77%). For each hour of student testing, these teachers spent 2-3 hours more in preparation, scoring, and recording. Testing, from a teacher perspective, is a time-consuming operation. Yet, most of the time, all a student sees is a final score due to the time and effort necessary to get diagnostic material from the test.

S-P Charts

The Student-Problem Package (Harnisch and Romy, 1985) provides informative reports including the S-P Chart, an ordering of the student's responses to items in the form of a table. Figure 1 is an example of the responses of 15 students to 10 problems (items). Each row of this response matrix contains the responses of a student; a "1" indicates a correct response while a "0" represents an incorrect response. The columns of the matrix correspond to items on the test. Each row sum shows the raw score (total score) for each student. The column sum shows the number of students correctly responding to each item.

	0	0	0	0	0	0	0	0	0	1	Row
Student	1	2	3	4	5	6	7	8	9	0	Total
Andy	0	1	1	1	0	0	1	0	0	1	5
Bart	0	1	1	1	1	1	0	0	0	0	5
Chip	0	1	0	0	0	0	1	0	1	0	3
Debi	1	1	0	1	0	1	1	0	0	0	5
Edna	1	1	1	1	1	1	1	0	0	1	8
Fred	1	1	0	1	1	0	0	0	0	1	5
Gail	1	1	1	1	1	1	1	1	1	1	10
Hank	1	0	0	0	0	0	1	0	1	0	3
Ilga	0	1	1	1	1	1	1	1	0	0	7
Jane	0	1	1	0	0	1	1	0	0	1	5
Kirk	1	1	0	0	1	0	0	1	1	0	5
Lane	0	0	1	0	0	0	0	0	0	0	1
Mary	0	1	1	1	0	1	0	1	0	0	5
Nell	0	0	0	0	1	0	0	1	1	1	4
Opus	1	0	1	1	0	0	1	0	1	0	5
Column	0	1	0	0	0	0	0	0	0	0	
Total	7	1	9	9	7	7	9	5	6	6	

Figure 1. Student Responses to 10 Items and Row and Column Sumns ('1' = Correct Answer, '0' = Incorrect)

The next step is to order problems from easiest (most number of students answering correctly) to hardest, and order students from highest to lowest total score. Figure 2 shows this rearrangement of Figure 1.

S-P Curves

Two useful lines can be drawn on an S-P Chart. The S-curve is drawn by placing a solid vertical line over each S whose position corresponds to the total test score earned by the student represented by that row. The S-curve is drawn by starting at the bottom of the chart and connecting the top end point of each vertical line segment to the bottom end point of the line segment to the left end point of the line segment above it.

This S-curve is a visual display of student proficiency levels. A vertical S-curve would represent a homogeneous classroom with most students performing similarly, while a diagonal S-curve evidences a heterogeneous classroom with a wide range of performance. An S-curve shifted to the right shows a high proficiency level.

The P-curve is drawn in a similar manner, but the roles of students and items are reversed. A dotted horizontal line segment is drawn over each P whose position corresponds to the number of students correctly answering the item represented by that column. The P-curve is completed by starting at the bottom of the chart and connecting the right end point of the line segment above it. Figure 3 shows the S-curve and P-curves from Figure 2.

	0	0	0	0	0	0	0	0	1	0	Row
Student	2	3	4	7	1	5	6	9	0	8	Total
Gail	1	1	1	1	1	1	1	1	1	1	10
Edna	1	1	1	1	1	1	1	0	1	0	8
Ilga	1	1	1	1	0	1	1	0	0	1	7
Andy	1	1	1	1	0	0	0	0	1	0	5
Bart	1	1	1	0	0	1	1	0	0	0	5
Debi	1	0	1	1	1	0	1	0	0	0	5
Fred	1	0	1	0	1	1	0	0	1	0	5
Jane	1	1	0	1	0	0	1	0	1	0	5
Kirk	1	0	0	0	1	1	0	1	0	1	5
Mary	1	1	1	0	0	0	1	0	0	1	5
Opus	0	1	1	1	1	0	0	1	0	0	5
Nell	0	0	0	0	0	1	0	1	1	1	4
Chip	1	0	0	1	0	0	0	1	0	0	3
Hank	0	0	0	1	1	0	0	1	0	0	3
Lane	0	1	0	0	0	0	0	0	0	0	1
Column	1	0	0	0	0	0	0	0	0	0	
Total	1	9	9	9	7	7	7	6	6	5	

Figure 2. Students Arranged from High to Low and Items Arranged from Easiest to Most Difficult

In an ideal classroom and test, where everything tested is taught and learned, the S- and P-curves would coincide. Normally these curves diverge slightly due to individual differences in the classroom. If the test measures information not covered in the classroom, the divergence will be increased. A large divergence between the curves signals a possible mismatch of test objectives and instructional objectives in the classroom. A disparity index is given in the SPP analyses for each S-P chart. A disparity greater than .6 is a danger signal (Harnisch, 1983).

Student response patterns can be examined to determine the accuracy of the students' total score. Students response patterns are unusual to the extent that students answer easy items incorrectly, while answering difficult items correctly. Many factors lead to unusual response patterns including: sporadic study habits, absence when a topic was covered, carelessness, a common misunderstanding, test anxiety, not feeling well, poor test taking skills, short attention span, or copying answers. Also, hidden strengths due to experiences outside the classroom or unusually high interest in a specific topic, can lead to unusual response patterns.

Response Patterns

Response patterns for items are unusual to the extent that items are answered incorrectly by high scoring students and correctly by low scoring students. This situation suggests guessing by students, or something unusual about the item, e.g., its wording or what is being asked.

The unusualness of a response pattern can be represented by an index based on Student-Problem Curve Theory, the Modified Caution Index (MCI). The MCI student formula includes values such as student's total score and number of persons that got each item correct (see Harnisch and Linn (1981) with the MCI for an item computed in a similar manner. MCI's ranges from 0 to 1 where 1 represents a response pattern totally inconsistent with the expected pattern, while 0 represents a pattern totally consistent with the expected performance. The larger the MCI value, the greater the indication that the response pattern represents a major departure from an expected pattern. Typically, MCI's greater than .30 means the total score should be considered with caution.

```
                    Problem Number
                 0 0 0 0 0 0 0 0 1 0   Row
Student          2 3 4 7 1 5 6 9 0 8   Total
--------------------------------------
Gail   |         1 1 1 1 1 1 1 1 1 1S           | 10
       |                                        |
Edna   |         1 1 1 1 1 1 1 0S1 0            |  8
       |                                        |
Ilga   |         1 1 1 1 0 1 1S0 0 1            |  7
       |                                        |
Andy   |         1 1 1 1 0S0 0 0 1 0            |  5
       |                                        |
Bart   |         1 1 1 0 0S1 1 0 0 0            |  5
       |                                        P
Debi   |         1 0 1 1 1S0 1 0 0 0            |  5
       |                                 P P    |
Fred   |         1 0 1 0 1S1 0 0 1 0            |  5
       |                      P P P             |
Jane   |         1 1 0 1 0S0 1 0 1 0            |  5
       |                                        |
Kirk   |         1 0 0 0 1S1 0 1 0 1            |  5
       |           P P P                        |
Mary   |         1 1 1 0 0S0 1 0 0 1            |  5
       |                                        |
Opus   |         0 1 1 1 1S0 0 1 0 0            |  5
       |P                                       |
Nell   |         0 0 0 0S0 1 0 1 1 1            |  4
       |                                        |
Chip   |         1 0 0S1 0 0 0 1 0 0            |  3
       |                                        |
Hank   |         0 0 0S1 1 0 0 1 0 0            |  3
       |                                        |
Lane   |         0S1 0 0 0 0 0 0 0 0            |  1
--------------------------------------
Column       1 0 0 0 0 0 0 0 0 0
Total        1 9 9 9 7 7 7 6 6 5
```

Figure 3. S-P Chart (S- and P-Curves superimposed) for sample data.

The Modified Caution Sign (MCS) is an aid for quickly identifying students with unusual response patterns. An 'A' signifies an adequate total score (determined by the teacher) and a consistent response pattern (MCI < .30), a 'B' signifies an adequate total score but inconsistent pattern (MCI > .30), 'C' indicates a low total score but consistent pattern, while 'D' indicates both low total score and an inconsistent pattern. A teacher can quickly find students with B's and C's in the MCS column. These scores should be considered with caution, and responses examined.

Modified Caution Signs for items are assigned in a similar manner. An item that is relatively hard and has a high MCI will have an MC of 'X'. A hard item with a low MCI will be assigned a 'W', an easy item with a low MCI will be assigned a 'Y' and an easy item with a high MCI will be assigned a 'Z'.

```
  Student   Test Score  Caution   0 0 0 0 0 0 0 0 1 0
  Number    (Raw)( % )  Ind/Sgn   2 3 4 7 1 5 6 9 0 8
-----------------------------------------------------
Answer Key =====================>  B C A A D A B D D C
-----------------------------------------------------
      Gail   10  100.0  0.00 A  | + + + + + + + + + +S|
                                |                     |
      Edna    8   80.0  0.00 A  | + + + + + + + BS+ A |
                                |                     |
      Ilga    7   70.0  0.17 C  | + + + + A + +SA C + |
                                |                     |
      Andy    5   50.0  0.07 C  | + + + + ASB C C + A |
                                |                     |
      Bart    5   50.0  0.14 C  | + + + C BS+ + C B A |
                                |                   P |
      Debi    5   50.0  0.14 C  | + B + + +SC + C B A |
                                |               P P   |
      Fred    5   50.0  0.36 D  | + A + B +S+ C A + A |
                                |         P P P       |
      Jane    5   50.0  0.21 C  | + + C + BSC + A + A |
                                |                     |
      Kirk    5   50.0  0.64 D  | + B C B +S+ C + C + |
                                |   P P P             |
      Mary    5   50.0  0.29 C  | + + + C BSB + A C + |
                                |                     |
      Opus    5   50.0  0.36 D  | A + + + +SD C + B D |
                                | P                   |
      Nell    4   40.0  1.00 D  | A D C CSB + C + + + |
                                |                     |
      Chip    3   30.0  0.25 C  | + D BS+ B B C + C D |
                                |                     |
      Hank    3   30.0  0.58 D  | A B BS+ + C C + B D |
                                |                     |
      Lane    1   10.0  0.33 D  | AS+ C C C B A A B D |
                                |                     |
-----------------------------------------------------
Problem Number  ===============>  0 0 0 0 0 0 0 0 1 0
                                  2 3 4 7 1 5 6 9 0 8
```

Figure 4. S-P Chart with Distractors, Scores, and MCI's

Identification of Unusual Items

S-P charts can identify items students may not have had opportunity to cover, poorly written items, or those with an incorrect answer key. The MCI of an item indicates item fit to students. If the item MCI is greater than .30 (that is, indicated with 'X' or 'Z' for its MCS), the item should be reviewed before it is used again. For multiple choice items, analysis of distractors is simple with an S-P Chart. By looking down the item column one can see if the higher scoring students are choosing different distractors than those nearer the bottom. This type of analysis aids in the understanding of right/wrong answers as well as decisions on whether an item should be included in a test bank.

Illustration of SPP Output

The SPP program produces an S-P Chart and other analysis from student responses to a set of items. Figure 4 shows an S-P Chart. Here, instead of the right/wrong data, the distractors chosen are input for the program. From an answer key, SPP scores each item and ranks students from highest total score to lowest. Items are ranked from left to right, from easiest to hardest. For each student the S-P Chart lists raw score, percent answered correctly, MCI, MCS, and responses (if correct, a '+' is printed, otherwise the distractor chosen is printed). For open ended questions where the student responses are recorded as ones and zeros, the scored data (1/0) would be printed in the chart.

In Figure 4, Gail had the highest score (10 out of 10 correct), while Lane had the lowest (1 out of 10). The easiest item, answered correctly by 11 of the 15, is item 2; the hardest item is item 8. Although eight students had a score of 50%, these scores should be considered with caution. Fred, Opus, and Kirk have 'B' Modified Caution Signs. Kirk's test especially should be examined for problems that would cause him to miss items (3, 4, and 7) that the class found relatively easy.

Nell, Hank, and Lane have MCS's of 'D'. Consider Nell's 40% score. She missed the easier problems, yet got all of the harder ones correct. Maybe she was ill the day of the test, or careless on items she thought were too easy. A teacher should look carefully into Nell's situation before recording this score. The format of the S-P Chart makes these observations simple and straight forward.

Analysis of the distractors can be useful in creating test banks. For example, look at item 8 in Figure 4. The higher scoring students chose distractor 'A', while lower achieving students chose 'D'. Distractor 'B' was never chosen. These distractors should be examined to determine how this item is performing.

Other Information produced by SPP.

In addition to S-P Charts, SPP computes item statistics such as percent correct, MCIs and MCSs, average item difficulty (average percent correct), reliability, average raw score, and other descriptive statistics. Figure 5 shows some of this additional SPP output.

Note that item 9 has been flagged by its MCS. Looking again at Figure 4 and the column for item 9, it is easy to see why. Most high scoring students missed item 9, while most lower scoring students got it right. This item may need to be rewritten, the answer key might be wrong, or it could be a confusing question not to be used on future tests.

The disparity coefficient for this test (from Figure 5) is .94. The high value implies that this test does not fit this classroom. The test is not necessarily too hard. But the curriculum should be compared to the test objectives for gaps in coverage. And some test items might need rewriting (MCI's can be used to pick out the items to be considered).

Categorized S-P Charts

In addition, the SPP program allows analysis by various subsets of items, such as curriculum objectives, to produce a Categorized S-P Chart. For example, if items can be grouped into categories such as addition, subtraction, and multiplication, a Categorized S-P Chart reports performance of students, test items, and classroom within these categories. Category groups are ranked left to right from easiest to hardest using the average class percent correct in that category. Then items within each group are ordered from easiest to hardest. A Categorized S-P Chart can be used to identify content areas where the classroom may need further instruction and practice as well as areas where students have unusual strengths/weaknesses.

```
Problem  Answer  Problem  Percent  Caution
Number   Key     Total    Correct  Ind/Sgn
   2       B       11      73.3    0.11  Y
   3       C        9      60.0    0.21  W
   4       A        9      60.0    0.00  W
   7       A        9      60.0    0.21  W
   1       D        7      46.7    0.21  W
   5       A        7      46.7    0.05  W
   6       B        7      46.7    0.00  W
   9       D        6      40.0    0.53  X
  10       D        6      40.0    0.16  W
   8       C        5      33.3    0.21  W
****  TEST  SUMMARY  ****
Average overall student
    performance on test (%)    = 50.67
Reliability coefficient
    (Cronbach's alpha)         =  0.53
Disparity coefficient          =  0.94
```

Figure 5. SPP test summary output.

Figure 6 shows a Categorized S-P Chart. For this class addition was the easiest content area, then subtraction, then multiplication. Although ranking of the students has not changed, this new organization brings to light additional information. Fred's strength in subtraction, not evident in the regular S-P Chart, is clearly visible. And Nell, the student with the highest MCI, has a real strength in multiplication. This helps in understanding why her response pattern was unusual. She might have practiced multiplication to the exclusion of other topics.

This organization of items into categories or objectives more closely matches the way teachers present topics. The results of a test can be utilized quickly when presented in this format. The teacher can see which content areas are understood (listed on the left) and, therefore, can be considered strengths. The last few tics may need extra review and concentration. Since items are ordered easiest to hardest within each category, this helps the teacher spot items within each content areas giving the classroom trouble. On the student level, the chart can pinpoint areas for concentrated work. Students with strengths can be spotted and paired with those who need help.Using only one item to measure an objective is unreliable. The student might get careless, getting an item wrong that he should get right, or by guessing get an item right that he did not know. One way to get test scores that are more reliable is to have several items that test one objective or skill. These skills can be further grouped into subtests.

```
                                     Problem Number
   Student   Test Score  Caution  0000 000 010
   Number     (Raw)( % )  Ind/Sgn  2376 415 908
 ---------------------------------------------
 Category Name ================>  Addi Sub Mul
 ---------------------------------------------
 Answer Key ===================>  BCAB ADA DDC
 ---------------------------------------------
       Gail   10  100.0  0.00 A | ++++ +++ +++ |
       Edna    8   80.0  0.00 A | ++++ +++ B+A |
       Ilga    7   70.0  0.17 C | ++++ +A+ AC+ |
       Andy    5   50.0  0.07 C | +++C +AB C+A |
       Bart    5   50.0  0.14 C | ++C+ +B+ CBA |
       Debi    5   50.0  0.14 C | +B++ ++C CBA |
       Fred    5   50.0  0.36 D | +ABC +++ A+A |
       Jane    5   50.0  0.21 C | ++++ CBC A+A |
       Kirk    5   50.0  0.64 D | +BBC C++ +C+ |
       Mary    5   50.0  0.29 C | ++C+ +BB AC+ |
       Opus    5   50.0  0.36 D | A++C ++D +BD |
       Nell    4   40.0  1.00 D | ADCC CB+ +++ |
       Chip    3   30.0  0.25 C | +D+C BBB +CD |
       Hank    3   30.0  0.58 D | AB+C B+C +BD |
       Lane    1   10.0  0.33 D | A+CA CCB ABD |
 ----------------------
 Problem Number  ==============>  0000 000 010
                                  2376 415 908
```

Figure 6. Categorized S-P Chart

For other sample printout showing these and other options see the expanded paper on the CD-ROM version of the Annual.

Summary

Analysis of item response patterns using the S-P approach provides a method of systematically looking at achievement patterns on common areas of content. Detailed output from SPP gives a teacher a concise report identifying instructional areas in need of review as well as students with unusual response patterns. Diagnosis of the procedural errors as identified in these analyses is an important area of interest to many educators.

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SCIENCE

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Information Technology in Science Teacher Education

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Technology in science education and science teacher education is often under-utilized. Even when available, computers are typically used only as word processors, electronic "worksheets," or as modern textbooks. The papers in this section provide a wide range of alternatives, which involve both high-level thinking and activity.

To begin this section, Knezek, Southworth, Christensen, Jones, and Moore review categories of hands-on science programs that use technology to provide constructivist-grounded opportunities for students. They discuss existing teacher training paradigms which are generally used with such programs and stress training as an important aspect of using technology within the science curriculum.

Coppola and Toth review a high performance computing initiative, EarthVision, designed to provide both teacher development and student learning through technology use. In this program, teacher-student teams are formed and work together throughout each phase: Saturday Tutorials, Summer Research Institute, School-based Research and School-wide Educational Plan Implementation.

Applying computer use in preservice teacher education, Nelson and Pan use a concept attainment model in conjunction with HyperCard stacks and videodisk images to encourage students to use reasoning skills in determining the characteristics of a category. Their paper describes the initial construction process of this program and the results of using this program with preservice elementary teachers.

Thirunarayanan also discusses the use of technology with preservice elementary teachers; however, he uses it to develop lines of communication among students as they work in the field. As part of his science methods course, Thirunarayanan makes an electronic discussion list available for his students. They may make use of this list to hold discussions amongst themselves and with Thirunarayanan. He offers suggestions on how to set up electronic discussion lists and how to train students to make good use of them.

The electronic forum is also the focus of the Muscella and Di Mauro paper. They examine the purposeful use of telecommunications by teachers and the components of "good" conversations in an electronic discourse. Analysis of conversations on the LabNet network includes a dialog exploring scientific theories. The network,used by K-12 science and math teachers, is also described in this paper.

Finally, Boice, Redfield, and Hooper examine the vehicle of mentorship to encourage talented students, including females and minorities, to pursue science and engineering fields. The Young Engineers and Scientists (YES) mentorship program is described and the effects of using technology in teacher education through this program are reviewed.

The papers in this section provide high quality alternatives for teacher education enrichment through the use of technology. Although the number of papers is small, the quality of ideas is inspiring. Perhaps the sharing of these ideas will spur a greater number of papers for next year.

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Educating Teachers for Hands-on Science

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The need to revitalize U.S. science education has been well documented over the past decade by individual researchers, government agencies, and non-governmental organizations (Halloun & Hestenes, 1985; Shair, 1990; Tinker, 1992; American Association for the Advancement of Science, 1993). For example, in 1992 the Educational Testing Service reported that junior high students in the U.S. placed in the bottom three among twenty nations on an international comparison of science scores (Asahi News, 1992).

In response to this need, several new approaches to science education have been introduced. These often involve the use of emerging information and communication technologies, and typically focus on direct scientific inquiry in a cooperative, problem-solving environment (Bruder, 1993). This student-centered, experimental approach to science education has come to be known as hands-on science (Lenk, 1992; Shair, 1990).

Examples of Hands-on Science Activities

Hands-on science initiatives in the USA vary widely in scope, origin, and purpose. Representative examples from four categories of hands-on science activities are provided in this section.

Inquiry-Based Curricula

Foundational Approaches in Science Teaching (FAST), by the University of Hawai'i Curriculum Research and Development Group (CRDG), is a long-standing example in this category. FAST is an inquiry-based, three-year, student-centered, sequenced program. It emphasizes integration-building connections among the disciplines of science. Students study a variety of sciences each year in an interconnected way rather than isolated chemistry, physics, or biology. Investigations also focus on interactions of science and society, and particularly cultural perspectives, by dealing with both local and global issues. The attempt is to develop students who think globally and act locally. The program began development in 1968 and has been certified by the National Diffusion Network. It is targeted at middle school level students.

Currently, there are about 5,000 teachers serving about 450,000 students using FAST in 36 American states and 8 foreign countries. Students can nearly simultaneously collect environmental data on such topics as weather, soil, acid rain, ozone, water resources, ocean debris, etc. In order to support teachers and students using FAST, and to take advantage of the global data being collected by students, FAST uses a telecommunications network through which students share their data and their questions. The Hawai'i Network for Education in Science and Technology (HI-NEST) was begun in 1989 under a three-year grant from the Hitachi Foundation (Young, Gullickson-Morfitt & Southworth, 1993).

Expedition Telepresence (Riel & Harasim, 1994).

Project Jason was a pioneering example from this area. Undersea exploration "field trips" carried out in conjunction with Woods Hole Oceanographic Institute and supported by the Electronic Data Systems Corporation (EDS), included live television broadcasts to classrooms from a robot mini-submarine. In Project Jason, many sites monitored, while selected sites conveyed questions to the explorers.

A more recent project known as PASSPORT TO KNOWLEDGE relies upon electronic field trip modules which include live television broadcast, computer conferencing, on-line libraries, and classroom learning tools (Riel & Harasim, 1994). For example, the series Live From Antarctic is scheduled for showing through the Public Broadcasting System December 13 and 15, 1994. Use of data from Antarctica research sites and communication with South Pole scientists will be encouraged, via the Internet, in order to further extend initial interest and learning generated by the television broadcast (Riel, 1994).

Space Missions

An on-going activity in this category is the Shuttle Amateur Radio EXperiment (SAREX), which was initiated by the National Aeronautics and Space Administration (NASA), the Amateur Radio Relay League (ARRL), and the AMateur SATellite Corporation (AMSAT) in 1983. SAREX uses amateur radio to deliver live voice broadcasts from astronauts on missions in response to questions from students in kindergarten through college classrooms. It also enables machine-attended computer contacts with NASA's space shuttle (White, 1994).

Also in this category is the CAN DO project planned from 1984-1993 by the Charleston County (SC) School District and involving a series of student-run experiments which flew on the space shuttle Endeavour in a Get Away Special (GAS) canister. The scientific package included four cameras plus 261 test tubes filled with samples ranging from Alka-Seltzer to human hair, and the student's work produced many new high-resolution photos of the earth as well as "...a lifetime supply of self-confidence [for the students]" (Nicholson, 1994).

Network Science (Lenk, 1992).

These types of activities are based upon electronic mail communications between classrooms on a focused theme. They typically involve information gathering at multiple sites, as well as integrated analysis and discussion of social implications of findings. Selected examples are:

1. National Geographic Kids Network, begun in 1988 by matching National Science Foundation (NSF) and National Geographic Society (NGS) funds granted to the Technical Education Research Centers (TERC) in Cambridge, Massachusetts. It is now largely funded through individual classroom participant fees. NGS Kids Network historically featured half-year curricular units for grades 3-6 in areas such as acid rain, nutrition, garbage, weather, and water (Tinker, 1992). Comparable units for grades 6-9 are scheduled to become available in 1995 (National Geographic Society, 1994).
2. The AT&T Learning Network, sponsored by the American Telephone and Telegraph Corporation (AT&T), was begun as a trial program in 1987 and commercialized in 1990 (AT&T, 1994). This program places elementary through secondary schools in "Learning Circles" with schools/classrooms at other geographic sites for participation in units such as Classroom Connections, Computer Chronicles (newspaper production), Mindworks AT&T Creative Writing, Places and Perspectives, Energy and the Environment, Society's Problems, and Global Issues (Tada, 1993). A Learning Circle lasts 12 weeks in the fall and 15 weeks in the spring.
3. TERC's Global Lab Project, begun through partial NSF support, features half-year curricular units for grades 8-12 in areas related to health and the environment. Technical Education Research Centers (TERC) supplies measurement instruments for local site utilization. Like NGS Kids Network and the AT&T Learning Network, the Global Lab Project also requires the payment of a per-semester participant fee (TERC, 1993).
4. TCET's Air/Water Project, begun in 1991 by the State-funded Texas Center for Educational Technology (TCET), uses a "bottom-up" teacher-initiated project model from New Zealand. The Air/Water Project is currently in its fourth year of a fall planning, spring pilot testing, curriculum development cycle for telecommunications-based thematic elementary school units. The project relies on Internet-based voluntary participation by schools in the USA, New Zealand, Australia, and the United Kingdom.

Historical Foundations

Although most hands-on science initiatives are considered to be new trends (Knezek, 1994), the theoretical foundations upon which these projects are constructed are not new at all. Hands-on, technology-based science instruction has been advocated in published forums for at least 15 years (e.g.Tinker, 1979). Indeed, as previously mentioned in the case of FAST, inquiry-based, thematic approaches to science education have been under development for more than 20 years (Young & Pottenger, 1992). Most of the individual projects now in existence are grounded in the constructivist approach to knowledge acquisition, popularized by scholarly authorities such as Seymour Papert in the U.S., but known to Papert and other students of Piaget for more than 30 years (see for example, Inhelder, de Caprona, and Corn-Wells, 1987). Less well-known in the U.S. but comparable in length of history and relevance is the work of Russian psychologist Lev Smenovich Vygotsky (1978). Vygotsky's admonition that "all meaningful learning occurs in a social context" is certainly a solid psychological foundation for those who tout the special significance of collaborative learning in hands-on science. And, finally, not to be overlooked is the strong rationale for inquiry-based learning in the Discovery Learning approach convincingly advocated by Jerome Bruner (1962) more than three decades ago.

Effects on Learning

Proponents of hands-on science have gathered evidence that "... it supports deep, interdisciplinary, collaborative study, it puts the student in charge of his or her own learning, and it makes learning relevant and interesting (Tinker, 1992, p. 35)." Researchers have also been able to determine that it can indeed result in better intuitive understanding of science (Thornton and Sokoloff, 1990; Warren, Rosebery, and Conant, 1989) and improved student performance in several curricular areas (Bredderman, 1985; Waugh, Miyake, Levin & Cohen, 1988; Cohen & Riel, 1989; Mokros, Goldsmith, Ghitman & Ogonowski, 1990). In addition, educators report that this approach appears capable of motivating students to continue with informal science education as part of their lifelong learning processes (Bruder, 1993; Tada, 1993).

International Perspectives

From the perspective of the world community, it appears that educators in other nations are also becoming convinced of the worth of collaborative hands-on science education. Most of the projects described in this paper involve schools outside the USA, even though the multiple-site collaboration is often in English as a Foreign Language (EFL). Initiatives are also underway to alleviate language and culture barriers inherent in U.S.-developed materials. For example, in 1992 educators in Russia and Slovakia began separate projects to translate FAST into their national languages. In the Russian case, five schools had electronic mail connections with each other and with students from the University of Hawai'i Laboratory School. Educators from Educational Colleges in Barnaul, Ryazan, Voronezh, and Krasnoyarsk University and the Scientific Council for Cybernetics, Russian Academy of Sciences in Moscow, monitored the project. After translation, verification, cultural and environmental adaptation, and teacher training, the schools have now taught the program for one year (Young, Gullickson-Morfitt & Southworth, 1993).

Existing Teacher Training Paradigms

Teacher training is a well-established ingredient for success in most curricular endeavors. In the area of hands-on science, the need to establish competence and confidence (comfort) is especially acute as the activities often involve non-trivial data acquisition, analysis, and communication technologies. Longer-established projects have recognized and address these needs. For example, staff development training is required of all teachers using the FAST program. It is coordinated with the program dissemination by CRDG. TERC has an extensive offering of printed materials to guide teachers participating in its hands-on activities. Because locally-initiated electronic exchanges are being attempted by classroom teachers in ever-increasing numbers, curricular guides such as the series under production by the Texas Center for Educational Technology (Christensen, Clayton, Campbell, & Knezek, 1994) are becoming available.

Most hands-on science teacher education alternatives fit into one of the following four categories:

1. Formal Staff Development,
2. Project-Centered Outreach,
3. Peer Apprenticeship, or
4. Self-Education.

For example, the previously-described FAST model belongs in category 1, while TERC mailings and electronic mentoring activities fall into category 2. The model of an innovative lead teacher promoting interest and competence among fellow teachers in a school is becoming a more common instance of category 3, while the lone teacher-innovator (category 4) attending conferences, reading, and sending electronic mail queries, remains a common way that hands-on science is brought into many schools.

Although the examples listed in the previous paragraphs indicate promising trends, it is nevertheless true that the avenues through which hands-on science teachers can currently receive their training are quite limited. Noticeably absent are training for participation in hands-on science initiatives at the preservice teacher education level, or preparation for hands-on science in inservice-technology training programs.

In addition to the shortage of well-trained teachers, other barriers restrict the wider dissemination of hands-on science activities. One is that the technology required to implement hands-on science activities on a national or global scale is still in its infancy. Telecommunication links in particular are not pervasive in elementary and lower secondary classrooms in the U.S. — phone lines are currently available in just 5% of U.S. classrooms (Auletta, 1994).

Also not to be overlooked is the accountability issue. It is often difficult to show that students participating in hands-on science have more fully mastered the kinds of "essential element" skills often listed and tested for in standard state or national curricula. Teacher education institutions may wish to train prospective hands-on science educators in portfolio assessment and other alternative assessment techniques, in order to respond to this need.

Conclusion

Since the publication of *A Nation at Risk* by the National Commission on Excellence in 1983, there has been a strong emphasis on restructuring education in the USA. Yet, despite funding for the transformation of schools through technology, scholars such as Kromhout & Butzin (1993) have pointed out the current classroom curriculum remains largely driven by lectures, textbooks, and passive learning.

Hands-on science appears to have great potential as a practical approach to restructuring science education away from the passive mode of learning. As science educator Robert Yeager (1983) asserted more than a decade ago, "to experience science is to begin to understand it." This sentiment was recently echoed by St. Mary's International School (of Tokyo, Japan) science teacher Jim Galles: "Real science, where the students actually find out something that is not known, is a positive experience (Galles and Tada, 1994)." Veteran teachers are discovering that hands-on science activities can instill new life in their curricula. Teacher education programs should plan to incorporate training experiences which foster confidence and competence on the part of educators in the use of these techniques.

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EarthVision: Teachers and Students Learn to Use High Performance Computing Together

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EarthVision is a high performance computing initiative designed to provide teachers with professional development and infuse high performance computing and communication technologies in school science teaching and learning. EarthVision is funded by the US EPA and is managed by Saginaw Valley State University in collaboration with the National Environmental Supercomputer Center (NESC) in Bay City, Michigan. EarthVision includes Saturday Tutorials, Summer Research Institute, School-based research and School-wide education plan implementation.

This paper describes each phase of EarthVision and details the activities teacher-student teams jointly participate in at each phase. The paper also describes a curriculum for teaching computational science in a Saturday Tutorials format and outlines the interdisciplinary curriculum one of the participating EarthVision high schools has implemented.

Researchers of educational reform movements have previously concluded: "The Teacher is the key for educational reform" (Harris and Anderson 1991). It has been predicted that the 1990's will be the era of education where teachers will be focal points in facilitating knowledge understanding, generation and quality application (Bauer, 1991). In order to establish this teacher centered model of reform, teachers need to design and implement innovative instructional technology projects and curricula enabled by teacher- support, time, access, resources and training (Thurston, 1992).

EarthVision is built on teachers' needs assessment and is implemented with special emphasis on proper training for teacher/student teams during Saturday Tutorials and Summer Research Institute. EarthVision participants also receive a Silicon Graphics Workstation with software to implement their research. Mentor experts and the EarthVision support team also provide continuous, on-site support for teacher/student teams.

Hands on experimentation as opposed to reliance on textbook centered activity use has also been emphasized in many reform efforts. Surveys examining the effects of reform movements by Mullis and Jenkins (Mullis and Jenkins, 1988 as cited in Blosser, 1989.) show that textbook centered activity still dominates over experimentation and use of scientific equipment in classrooms. EarthVision is a project that enables students and teachers to conduct hands-on scientific experiments and learn the scientific research process in an authentic setting.

What are the experiences of teacher/student teams participating in the EarthVision project, that contribute to school wide reform movements? EarthVision provides an authentic learning and research experience for teachers and students and assist teachers in preparation of a new interdisciplinary curricula for education reform at their school. In this paper we outline the design and implementation of Saturday Tutorials and describe the experiences of teachers and students participating in EarthVision. We believe this project could serve as a model for successful teacher training and school infusion of high performance computing and communication.

Four Stages of a Successful Model

EarthVision: EPA's Challenge for High Schools started in 1993 and is now in its second cycle. One cycle consists of four phases: Saturday Tutorials, Summer Research Institute, School Based Research, and School-Wide Implementation.

1. Saturday Tutorials

Teams of two teachers and four students from high schools are eligible to apply for admission to the EarthVision Saturday Tutorials that have taken place at the National Environmental Supercomputer Center in Bay City, Michigan. At each Saturday Tutorial session teachers and students participate in hands-on explorations, as well as guided discovery and demonstrations, which facilitate learning of environmental science, mathematics, computer programming and electronic communications. The selected method for hands-on investigation in the environmental science area is Computational Science.

What is Computational Science? Computational science is a new way of conducting scientific experiments with the uses of high performance computing and communications techniques. Computational science is interdisciplinary in nature as it involves science, computer science, mathematics and an art related data representation technique: scientific visualization. An increasing number of scientists use a computational science approach for scientific investigation.

The process of computational science investigation is similar to that of experimental and theoretical investigations fusing characteristics and benefits of both methods. A typical investigation using the computational method has the following steps:

1. Initial data, information gathering
2. Scientific Question formulation
3. Scientific Hypothesis formulation based on a scientific theory
4. Theoretical Model development
5. Mathematical Model development
6. Coding mathematical equation using a programming language.
7. Visualization of code output
8. Analysis using scientific visualization
9. Model refinement
10. Conclusion
11. Reporting

These steps are best represented as parts of a circular process with feedback from each step for the modification of the preceding step.

Why do we use computational science? This method gives researchers a new tool to learn about scientific phenomena that was hard or impossible to investigate with traditional methods. Such cases include phenomena that are too large or too small to investigate with experimental methods, the process in question is too dangerous or too costly for traditional investigations or the excessive length of investigations with traditional tools limits research possibilities.

Scientific phenomena that recently have been studied with computational methods include: regional acid deposition as a consequence of factory pollution and wind directions over the a geographical area; movement patters of lake/river pollutants as a consequence of seasonal water movement characteristics; and distribution and extent of forest fires in a certain area. In addition to providing an additional method for investigating scientific phenomena where experimentation is impossible, dangerous, slow, too long or costly, computational science enables scientists to explore alternatives, ask "What if?" questions, make predictions and allow extrapolation during their research.

The dangers of modeling here are also potential dangers of computational modeling that researchers and instructors have to face. (a) Mathematical assumptions and simplifications are necessary during the model building process. It is important to keep these assumptions in mind during the entire process. Failing to do so may result in false conclusion of research results. (b) A possible danger may result from investigators natural tendency for perfectionism. If too many variables are included from the initial stage on during the investigation the model quickly becomes unmanageable. (c) Prejudice is another possible danger and investigators must carefully watch their own mental processes. Failing to do so may result in interpreting observations to fit an initial model and not vice versa: creating models to fit scientific phenomena. (d) All models and simulations need to go through a stage of calibration and verification where variables of mathematical models are explored and outputs of the mathematical model are compared with field research data. Lack of adequate verification will result in false assumptions about scientific phenomena in question.

Prerequisites of Computational Investigations. To be successful, implementation of Saturday Tutorials designed to help teachers and students learn and utilize computational science in their research need to consider all the precautions above. In addition the interdisciplinary nature of computational science needs proper consideration as well. The prerequisites of conducting investigations with computational science are: (a) appropriate subject domain knowledge, (b) knowledge of mathematics and utilization of various mathematical techniques to describe scientific phenomena, (c) familiarity with computer programming and ability to use pre-developed scientific code or ability to develop computer code with a programming language suitable for high performance computing (i.e., FORTRAN or C), and (d) ability to work as a team member of an investigative team where role definitions, communication between members and reliability of collaborators are invaluable.

EarthVision Saturday Tutorial instructors teach in a team-teaching environment modeling a method teachers are most likely to use in the school-wide implementation of their school-wide education plan. Each instructor teaches one of the four areas described above. The instruction in these areas provides the knowledge base needed for the teams to design a research project using a computational approach and an education plan to implement environmental research and computational science curricula reform at their school. The EarthVision Saturday Tutorial instruction is

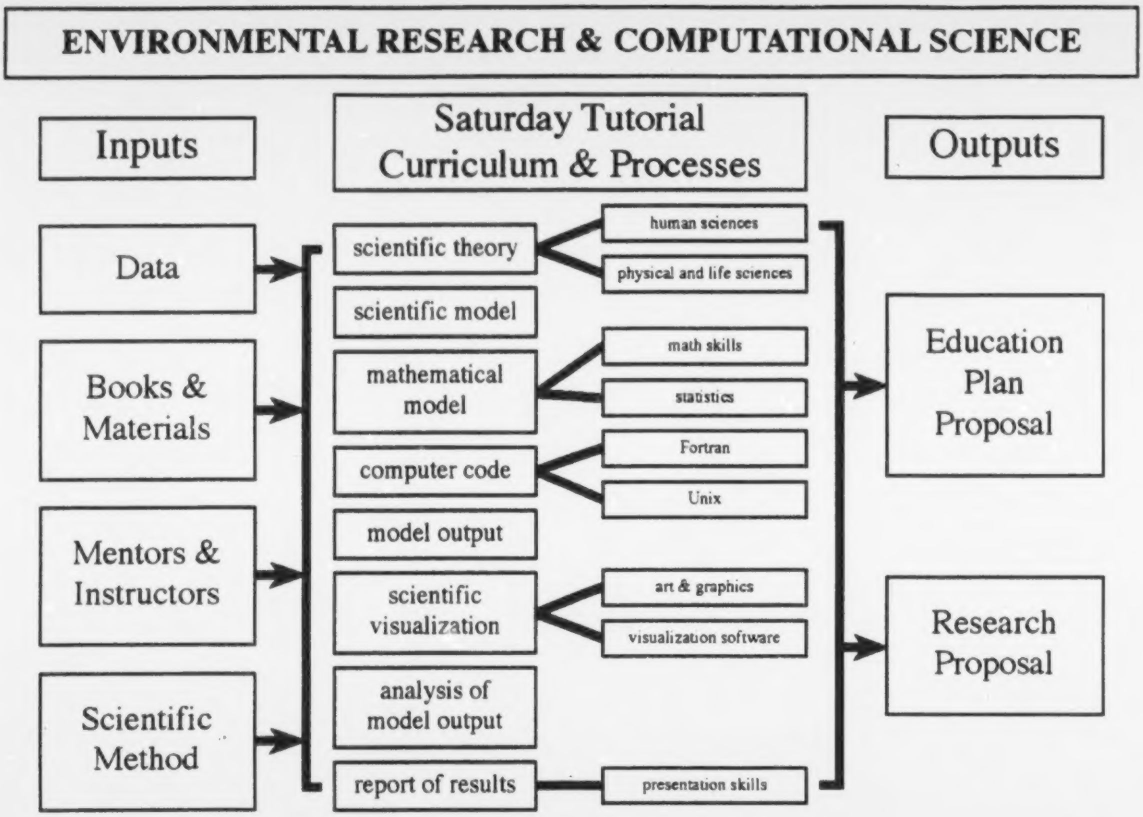
ENVIRONMENTAL RESEARCH & COMPUTATIONAL SCIENCE
Inputs
Saturday Tutorial Curriculum & Processes
Outputs
Data
Books & Materials
Mentors & Instructors
Scientific Method
scientific theory
scientific model
mathematical model
computer code
model output
scientific visualization
analysis of model output
report of results
human sciences
physical and life sciences
math skills
statistics
Fortran
Unix
art & graphics
visualization software
presentation skills
Education Plan Proposal
Research Proposal

Figure 1. EarthVision Saturday Tutorial Curriculum.

developed in two main streams. Participants learn to conduct computational investigations using a pre-developed computational model as an example. They are also required to work on two proposals: a research proposal describing a proposed environmental science investigation using computational science and visualization and an education proposal describing the teams plan for a school-wide implementation of innovative science program using computational environmental science. Curriculum processes, various inputs such as the reference and instructional processes and faculty and mentor expert support and instructional materials as well as the outputs of the Saturday Tutorials are summarized in Figure 1. For further details about the Saturday Tutorial curriculum and instruction see R. K. Coppola & E. Erdosne Toth (1994).

2. Summer Research Institute

During the Summer Research Institute (SRI), competitively selected teams receive in-depth instruction on conducting an environmental research project of their own design. Mentors scientists with knowledge of modeling and the specifics of the scientific phenomena being used in the team's research support the teacher-student teams. Lectures, hands-on laboratory time and discussions with mentors and other peers are scheduled daily during the Summer Research Institute. By the end of the SRI teams are ready to start their investigation of the chosen phenomena.

Each participating high school is supplied with a scientific workstation, and a telecommunications link to the National Environmental Supercomputing Center in Bay City. The Summer Research Institute serves as in depth preparation for the next part of EarthVision—conducting environmental research at their school.

3. School Based Research Support

During the following academic year, the teams implement their chosen environmental research at their high schools. They use their scientific workstation, and the supercomputer at the NESC, to analyze data, conduct environmental modeling and use scientific visualization to implement their research. The mentors advising each team continue to provide support. The EarthVision outreach team also visits the participating schools to assist in research and the school-wide educational program. The teams are expected to communicate the results of their research in professional and public forums. This requirement for professional review and public education is a major force in motivating teacher-student teams to progress their research and education plans.

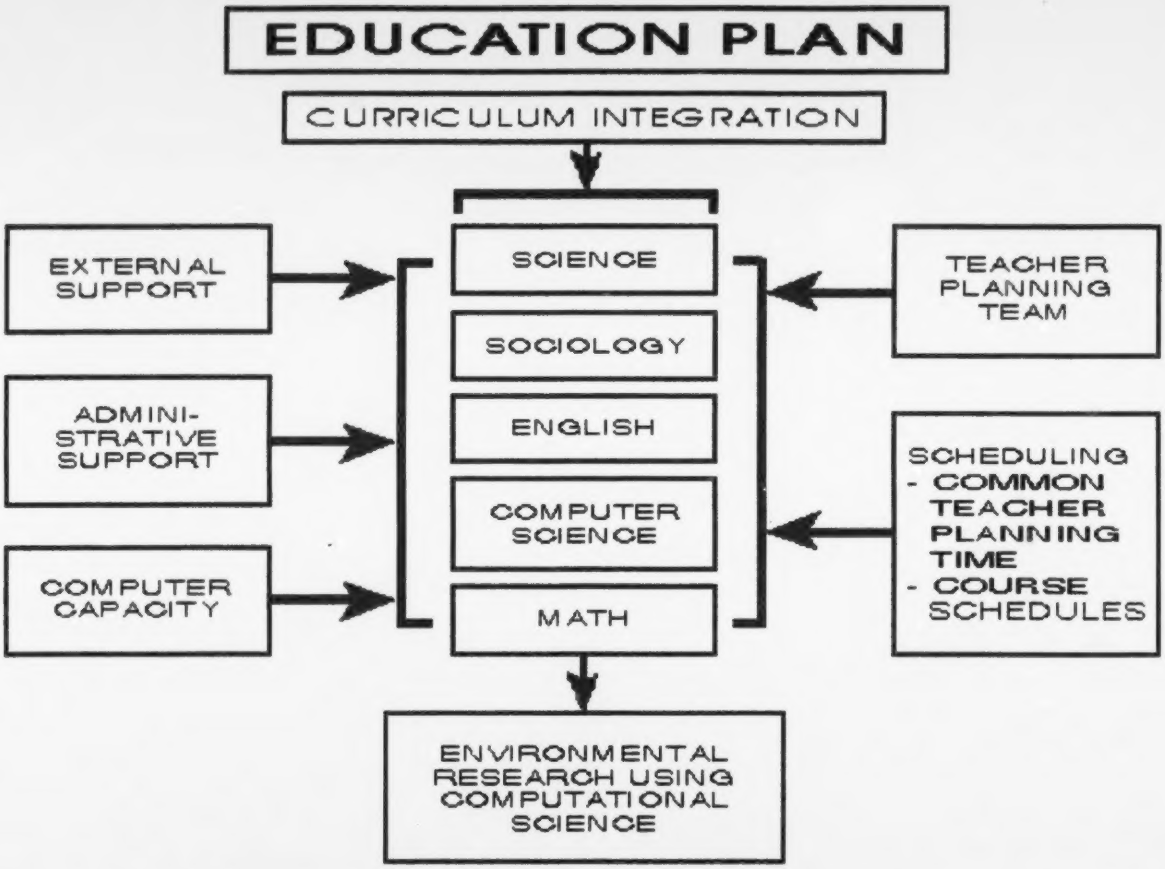
EDUCATION PLAN
CURRICULUM INTEGRATION
EXTERNAL SUPPORT
ADMINI-STRATIVE SUPPORT
COMPUTER CAPACITY
SCIENCE
SOCIOLOGY
ENGLISH
COMPUTER SCIENCE
MATH
TEACHER PLANNING TEAM
SCHEDULING
- COMMON TEACHER PLANNING TIME
- COURSE SCHEDULES
ENVIRONMENTAL RESEARCH USING COMPUTATIONAL SCIENCE

Figure 2. Components of School of Environmental Research (SER).

4. School-Wide Plan Implementation Support

The fourth phase of EarthVision is built on the Education "Reform" Plan proposals teams have submitted as part of their application to the Summer Research Institute. This proposal is an action plan for the student/teacher teams to implement a school-wide program infusing EarthVision in the regular classroom curriculum or into extracurricular activities. The first year winners of the EarthVision competition are in the Education plan implementation phase at this time. The interdisciplinary curricula they have designed is discussed next.

An Interdisciplinary Curriculum That Works

The first year EarthVision team implemented a team planning and teaching approach, topical instruction across disciplines, supported by computational science and traditional skill development all driven by research goals. To infuse environmental computational science into the entire school a School for Environmental Research (SER) was created with administrative support. The curriculum for this "school-within-a-school" is coordinated by collaborating faculty from five different departments: Science, Mathematics, Computer Science, English, Sociology. Figure 2 summarizes the SER plan.

During the 1994-95 school year sixty students were chosen from more than one hundred applicants to learn methods and processes of environmental computational science. Teachers utilize team-teaching, organize joint planning sections and use block scheduling to provide a more flexible environment for project based science learning. The SER incorporates the first integrated curricula EarthVision teachers and students have designed. Teachers given the proper support structure such as appropriate instruction, hands-on investigation opportunity, mentor and expert consultants and supportive school administrators were successful in initiating innovative school-wide reform.

During the Saturday Tutorials as well as during the school based research and education plan implementation collaboration plays a major role. The traditional roles of teachers and student are altered with both playing the roles of learner and teacher. Teachers, students and research scientists work together in a collegial manner to achieve common goals.

Interdisciplinary collaboration

Collaboration is invaluable in the success of scientific research using computational science because of the nature of the computational method itself. As it was outlined earlier conducting research using computational science requires collaboration between people with backgrounds in various disciplines. It is very rare that one person has all the knowledge necessary to address all of the major questions that need to be answered in order to develop a realistic computational model of scientific phenomena. As this is recognized by teachers and students team roles assignments are defined with specific division of labor. Roles are usually defined such that each team has a person with expertise in visualization, one member with computer programming expertise and one with experience in Internet research. The development of school-wide educational plan is usually the teachers' responsibility. Teachers request input from students and administrators and EarthVision staff members during the design of their education plan.

Peer Reviews

As the proposed research project is being conceptualized and developed teams have numerous opportunities to present their ideas, scientific questions and hypotheses to their EarthVision peers, as well as peers at distant locations. These peer reviews are considered part of the major drive for excellence in research and presentation. Peer review experiences motivate teachers and students to continue refining their research and enables them to learn from the results and problems of their peers.

Mentor Apprenticeships

As teams get ready to design their research projects mentors, experts in the subject domain are contacted by EarthVision staff and teams. Teams develop a unique relationship with these mentors. Mentors serve as role models for team teachers and students as they model successful processes of scientific thinking and problem solving. Thus, EarthVision teams learn environmental science in a cognitive apprenticeship with scientists, solving current environmental challenges, in a way that is very much like the traditional master-apprentice learning format.

Scientists often benefit from their work with EarthVision teams as well. EarthVision teams have access to up to date technology and high end workstations and software that some research laboratories and universities do not have. Scientists tend to enjoy seeing others continue work on topics which are a central part of their professional activity. This can lead to joint publications of research results using student generated scientific visualization as a new method to represent environmental research results.

Outcomes

Evidence of the positive effects of EarthVision is provided in teacher, student and systemic outcomes.

Teachers

Teachers feel empowered with a new method for educational reform and as a result of working closely with mentors and experts who have up to date experiences in science. Teachers also feel the satisfaction of being a key player in and establishing a new pedagogy for an overall school change. Educational uses of scientific investigation via computational science coupled with employment of pedagogical reform enable students and teachers to make a societal contribution.

Students

Students benefit from the realistic problem solving opportunity in many ways. Through the use of the scientific method they develop a sense of integrity and a guiding vision for their future career. The passion for achievement that is visible during their scientific research will be an invaluable asset during their career. They learn at this age the feeling of being able to contribute to society with the publication and presentation of their research results.

Systemic

Systemic outcomes include changes in the school system that are initiated by the empowerment of teachers and students through the use of networks and high performance computers. Schools establish relationships with the research community and help the public make informed decisions regarding science and the environment. With the infusion of the excitement of conducting "real" science and using modern technology, schools become high performance workplaces preparing students for the collaborative, technology rich work environment of the future.

Conclusion

The EarthVision challenge for teachers' professional development, student learning and systemic school-wide change provides a model for successful teacher education using hands-on scientific investigations and computational science. Contributing success factors are:

1. EarthVision instructors model the method of teaching to student/teacher teams,
2. the application of a new computational method used in conducting hands-on investigations is further refined for wide scale school reform by teachers and students,
3. appropriate instructional technology is established at school and continuous on-site support is offered to school teams,
4. connection to human resources such as mentor experts and peers is established and maintained, and,
5. school district administrative support to establish innovative curriculum at schools is provided by School Administrators.

More research is needed on the nature of effective enabling techniques using computational methods in science education but the case study of EarthVision points to some interesting possibilities for teacher training research and instruction.

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Concept Attainment Model: A Viable Component for Elementary Science Curriculum

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⊙ More Information on CD-ROM

The concept attainment model helps students learn to determine the characteristics of a category using reasoning skills (Lawson, 1993). Students view examples and non-examples of a category, compare the characteristics of the examples to those of the non-examples. Students then describe what they observe as similar and what they observe as different. The idea is for students to find a pattern of characteristics that distinguishes the examples from the non-examples. Students describe their thinking and share their strategies. After constructing a pattern for the common set of characteristics of the labeled examples, students then use their developed pattern to identify unlabeled samples as examples or non-examples. Joyce, Weil, & Showers (1992) reporte that after students learn a category for its characteristics, naming the category and using the category in other contexts are easier tasks.

Tennyson & Cocchiarella (1986) suggested that on retention measures, students using well selected example/non-example sets outperformed students using attribute lists or definitions. They stated that students rarely retain concepts when just given the definitions and names, in contrast, they suggest that the use of example/non-example sets invite students to compare and contrast the data. The process of comparing and contrasting information seems to help students retain concepts.

Description of the Pilot Project

The purpose of this study is to construct a concept attainment task using a HyperCard stack and videodisk images. The HyperCard stack that we initially designed used video images of insects from the science videodisk developed at the University of Kansas (LaShier, 1988). This program used the concept attainment model based on ideas from the interactive, videodisk program, *Criterion Characteristics of Some Invertebrates: A Taxonomic Perspective* (Nelson, 1989). This paper will describe two aspects of the initial construction process: 1) methods used to transfer videodisk images and developing a HyperCard stack, and 2) preservice elementary students' responses to using the HyperCard stack.

Transferring Videodisk Images and Developing a HyperCard Stack

There are two ways of using videodisk images in the computer authoring program: (a) interface computer with the laser disc player to control and display images on the videodisk, or (b) transfer images from the videodisk player to a computer hard disk and import graphics directly into the authoring program. To use the computer to control the images on the videodisk, the first method requires more hardware such as a computer, a videodisk player and probably an extra monitor. Although a laser disc can easily hold more high resolution images and graphics, it takes more work to develop and execute a program on the computer to display images on the monitor from a laser disc player.

This project was initially developed using the first method. A HyperCard stack was created to control the image display from the video disc to an external monitor.

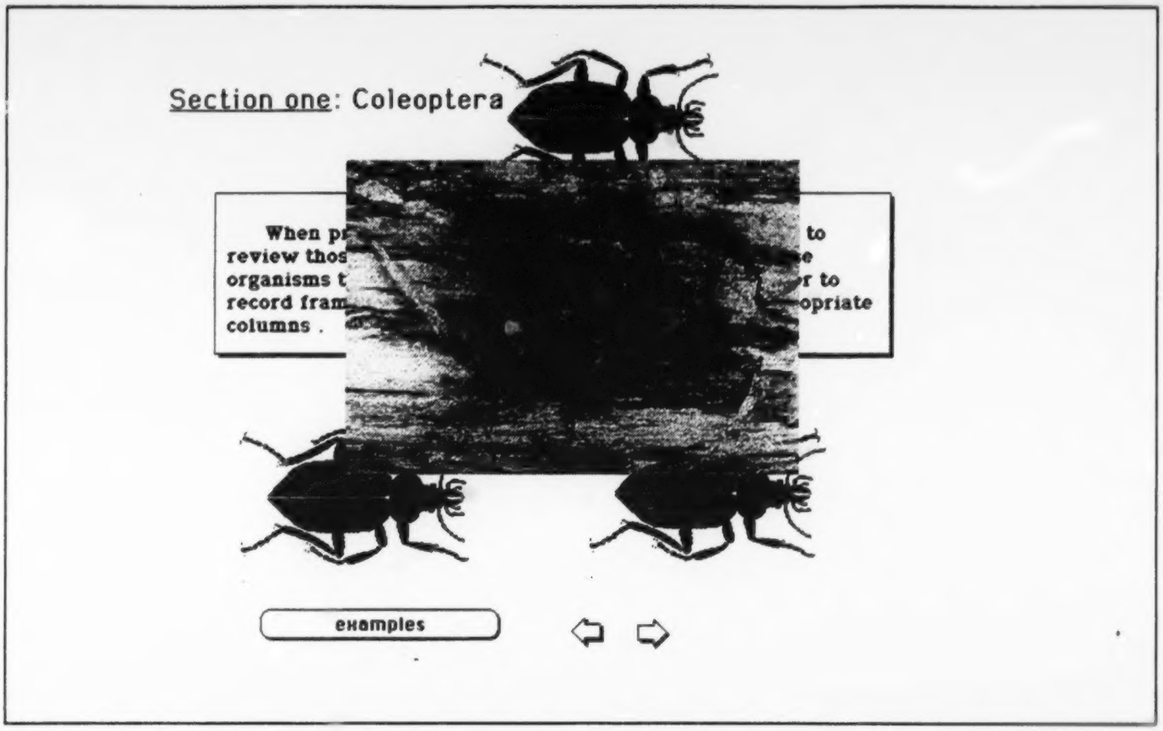


Figure 1: Viewing insect images.

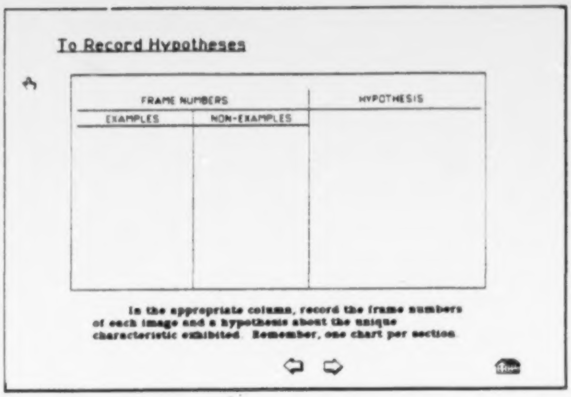
Due to the shortage of the needed equipment, such as the laser disc player, we further modified the project using the second method. We consider it appropriate to put the graphics onto the computer hard disk and interface with the HyperCard program. In such a way, all the desired color images of the insects can be called directly into the HyperCard stack. This reduces the extra hardware and software demand and increases the portability and ease of use for the program.

The transfer of the images from the laser disc to the computer hard disk is not a complicated process but requires certain hardware, software and knowledge about the transfer procedures. First, we connected the video disk player (Pioneer 4200) to an Apple Macintosh Qudra 840/AV system and then we ran the Video Monitor, a software program developed by the Apple Company, to display and transfer specified image frames from the video disc to the computer. Each image frame was saved as an individual TeachText picture file. Once the files are saved and renamed, they can be accessible to the HyperCard stacks.

The HyperCard stack starts with some general information about insects. Three particular insect groups were chosen for the major components of the stack. After the introductory screens, students decide the type of insect group they intend to learn. For each group, students view the available insect pictures in two approaches: 1) view all the example images in sequence and then view all the non-example images in sequence, 2) view a series of the alternating insect images of both examples and non-examples. Figure 1 shows the screen when a student clicks on the example button. Students can also record the image frame numbers and their hypotheses onto the computer as shown in Figure 2. After they have finished viewing all the insect images, they can go to the application screen where a series of randomized insect images of both examples and non-examples can be shown. Students, then, discriminate the example images from the non-example images. The HyperCard stack is used to record their choices.

Preservice Elementary Students' Responses to Using the Initial HyperCard Program

A total of 31 preservice elementary teachers viewed the pilot program. Students were asked to construct a list of their observations. Based on their observations, they were asked to construct a pattern that distinguished the set of examples from the non-example set. They were also asked to document their preference for how the sets of examples and non-examples were arranged. Do they prefer to view all the examples followed by all the non-examples, or do they prefer to see an alternating set of examples and non-example. The purpose was to document: 1) what preservice elementary teachers use to construct patterns from the example and non-example sets, 2) whether preservice



To Record Hypotheses

FRAME NUMBERS		HYPOTHESIS
EXAMPLES	NON-EXAMPLES	

In the appropriate column, record the frame numbers of each image and a hypothesis about the unique characteristic exhibited. Remember, one chart per section.

Figure 2. Recording the frame numbers and hypothesis.

elementary teachers' patterns helped them choose examples from a new set of examples and non-examples, and 3) how preservice elementary teachers approach the data that is provided in the examples and non-examples sets.

What type of information did students use to construct patterns? The patterns students constructed were placed into two categories, patterns that used observations and those that used inferences. Eggen & Kauchak (1988) described an observation as information gathered by using one or more of the five senses. In contrast, they defined an inference as a conclusion based on observations. Table 1 documents the percentage of students using observations and the percentage of students using inferences to construct a pattern. Of the 28 student responses, 19% of the students used observations to construct a pattern that distinguished the examples from the non-examples. The rest of the students, 81%, used inferences to construct their pattern.

Table 1.
Percentage of Students Using Observations to Construct Patterns V. Students Using Inferences

Ideas about the Pattern Stated	Percent (n = 28)
Used Observations	19%
Used Inferences	81%

After viewing the sets of images, most students reported that the examples have "hard wing covers". If students were working with a real beetle specimen, hard wing covers might be observed by some sort of tactile manipulation. When viewing images of beetles, however, the straight-line pattern that runs longitudinally down the back would be a viable observation.

These data point to activities needed in the HyperCard program that we initially overlooked. Perhaps we should precede the concept attainment task with some type of activity where students learn to distinguish observations from inferences.

Student Achievement of the Concept

After students viewed the sets of images and constructed a pattern that distinguished the examples from the non-examples, twelve new images were presented in random fashion. This task included new images of which 8 were examples and 4 were non-examples. Students used their constructed patterns to choose the examples. Of the 31 students assessed, 10% correctly chose 6 of the 8 examples and 58% chose 7 examples. A total of 32% of the students correctly chose all eight of the examples.

Table 2.
The Percentage of Students' Scores

Student Scores (Total = 8)	Percentage of Students (n = 28)
6	10%
7	58%
8	32%

The image missed most often was an example of a beetle that differed slightly from the rest of the images in the example set. This example was more elongate than the other images and not shiny. However, a distinct longitudinal line was present. Perhaps more examples presented in the original task might help students focus on the unique characteristics.

Students' Approach to the Data

Joyce, Weil, & Showers (1992) suggest that students use two distinctly different strategies to attain concepts. Partistic learners focus on just certain attributes of the provided data. Holistic learners use strategies to keep most of the provided data in mind. The students had the opportunity to view the images in two ways. They viewed a set of examples then a set of non-examples to create a situation for partistic thinking. They also viewed a set that had alternating examples and non-examples for holistic thinking. We asked students to document their preference for how these sets of images are displayed.

Table 3 shows the percentage of students who prefer either a partistic or a holistic strategy. Of the 28 students who documented their preferences for the arrangement of images, 46% indicated a preference for using a partistic strategy and 54% preferred the holistic approach.

Table 3.
Students' Preference for Partistic Thinking V. Holistic Thinking

Thinking Strategy (n = 28)	Percentage of Students
Partistic	46%
Holistic	54%

Baveja, Shower, and Joyce (1985) cited by Joyce, Weil, & Showers (1992) discuss the value of students sharing their thinking to modify and make their strategies more efficient. In their study, the partistic learners needed to constantly review the example/non-example sets. The holistic learners generated multiple hypothesis and eliminated those that were false. When provided the opportunity, students showed a willingness and ability to try new thinking strategies in subsequent lessons.

Summary and Implications

Initial responses for using concept attainment in an interactive, computer context are positive. Preservice elementary teachers constructed patterns to correctly identify examples of beetle images. The initial data suggest new avenues to pursue: 1) designing tasks that help students distinguish observations from inferences, and 2) how to utilize partistic and holistic learning contexts to investigate how students respond.

The preservice teachers were asked whether they thought concept attainment was appropriate for their elementary curriculum. There responses were favorable. A total of 31 students answered this question, 26 students (84%) responded positively. Two comments were representative:

> *It can be good [using concept attainment], because it allows a student to write down what they see. Not everyone sees everything the same. This allows for differences. It also give room for explanation of why they chose and organized what they did.*
>
> *This strategy makes the children classify and come up with their own rules - the only right answer is a justified one. I think children need to learn at a young age to make conclusions about what they observe, then seek justification for their conclusion. After thinking about the example/non-example [sets], I would compare and contrast the answers to see the variety, then we could all decide which are justified or not.*

The five preservice teachers (16%) that responded negatively to the same question, seemed concerned about the lack of direction or the complexity of thinking required for success. Lawson (1993) suggested that a teaching strategy specifically designed to show students appropriate reasoning strategies might help in the younger elementary grades.

In the future we want to investigate how elementary students respond to a concept attainment task. We are currenty developing the HyperCard stack to find out: 1) whether individuals respond differently than small groups of students and 2) whether a computer environment provides a different perceptual context for displaying examples and non-examples to elementary students. An assumption central to this study is that the concept attainment model asks students to construct a pattern. This task is novel to what elementary classrooms are accustomed. As Greeno (1989) states "thinking is an interaction between an individual and a physical and social situation" (p. 135).

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Some Experiences of Using an Electronic Discussion List in a Course

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A semester in universities in the United States is approximately seventeen weeks long. Classes generally meet for sixteen weeks, and the last week of the semester is usually designated as 'finals week' or the week when final exams are held and projects are due. Classes for a course typically meet once, twice, or three times a week for a total of three hours a week. If the university does not observe holidays on the days classes are scheduled to meet for the course, an instructor spends about forty-eight hours in class with her or his students during a semester.

Much is accomplished in class during the forty-eight hours when the instructor and her or his students meet in class. But much more can be accomplished if students are able to interact with each other outside the physical and temporal confines of a classroom.

On campuses and in departments where most of the students are traditional students who reside in dormitories, there are many opportunities for them to interact with each other outside the classroom setting to discuss work related to a course. However, in departments where most of the students are non-traditional students who commute long distances to attend classes, students may not have the opportunity to interact with others and share ideas and information related to a course in which they are enrolled.

An electronic discussion list provides plenty of opportunities for students to interact with each other outside the classroom, and to share ideas and information related to a course in which they are enrolled. In this paper, the author who is also the "owner" of an electronic discussion list, will describe his experiences of using an electronic discussion list in a course. He will also offer suggestions to others who may be planning to establish discussion lists for use by students enrolled in their courses.

How Does a List Function?

Since most of the readers of this document may already be familiar with discussion lists and how they function, only a brief and simple explanation is offered here. An electronic discussion list is simply a mailing list consisting of the e-mail addresses of users who subscribe to the list. To subscribe to a list, each user sends a message to the appropriate address with a single line in the text which reads:

```
Subscribe Listname Usersfirstname Userslastname
```

Once a person has successfully subscribed to a list, he or she will then start receiving all messages which are sent to the list by others who are also subscribed to the list. A subscriber can also send messages to the list. The messages sent to a list which are intended for distribution to all those who are on the list have to be sent to an address which is different from the address to which the 'subscribe' message was sent.

When a user sends a message to a list, a copy of the message is sent to all users who are currently subscribed to the list. Those who wish to respond to a particular message send their reply to the list, and copies of this reply are also sent to all subscribers. People who subscribe to a list can thus have electronic discussions with each other on topics which are of mutual interest to the group of subscribers.

Rationale for Setting Up an Electronic Discussion List

The author teaches an elementary science methods course for pre-service teachers. Students who enroll in this course attend classes at the university during the first half of the semester. The students are then placed in elementary schools for their internships during the second half of the semester. After they are placed in elementary schools for their internships, students in this author's course do not have much opportunity to meet regularly with all their classmates to share their experiences with each other. An electronic discussion list, whose name and address are being withheld in order to protect the interests of the students who subscribe to it every semester, was established primarily to enable students to communicate with each other while they are completing their internships.

Establishing a List

To initiate the process of establishing the discussion list, the author sent an electronic mail message to a system operator in the computing and data processing department, requesting some information on setting up a list. A few electronic mail messages later, the discussion list was created by the system operator.

After the discussion list was in use for a few weeks, the author who is also the "owner" of the list, sent a message to the system operator requesting a copy of the archive file. The author was informed that the archival feature was not activated when the list was created since the author had not specifically requested that this feature be activated. The system operator soon activated the archival feature at the author's request but by this time the list had already been in use for a few weeks.

The author was initially under the impression that once a list is established, all messages sent to it are automatically archived. He found out, fortunately within a few weeks after the list was in operation, that the software which was used to create the list does not automatically archive all messages sent to the list. This feature has to be activated by the person who creates the list. While this was a good learning experience for the author, it is unfortunate that the messages which were sent to the list during those first few weeks of its operation have not been archived.

If you are interested in setting up a discussion list for use by students enrolled in your courses, you should contact the computing services department on your campus. Once you find out the name of the person who is responsible for such activities on your campus, send an electronic mail message to that person asking the following questions and providing the following information:

1. What is the campus policy on setting up an electronic discussion list for use by students enrolled in a course? Give some information to the system operator explaining why you are interested in setting up a discussion list, how it will be used, and what you expect it to achieve. Such information may help the system operator to obtain permission, if necessary, from her or his superiors before setting up the list.

At this stage it may also be a good idea to find out what the campus policy is regarding offering computer accounts for all students who are enrolled in a course. Also find out if enough computer labs are available on campus for students to use.

2. Are there any charges or fees for setting up and maintaining a discussion list? If you find that the computing services department will charge your department for services related to setting up and maintaining an electronic discussion list, then you may have to get permission from the chair of your department before you proceed further. In these days of shrinking budgets, an administrator may not appreciate getting an unexpected bill from the computing services department a few months later.

3. Find out if other discussion lists are already being used on campus by other faculty members. Get e-mail address for the owners of other lists on campus. Send messages to other faculty members who may already be using discussion lists in their courses. They may be more than willing to share their experiences with you. Suggestions offered by other list owners could save you a lot of time, and enable you to avoid the problems which they faced.

4. Specify the features you want your list to have. Don't assume anything. Find out the major default and optional features which are available in the software which will be used to create the list. You may have to consult a manual before you become familiar with the various features which are available and before you are able to make an informed decision about the features which you want to incorporate into your list.

The system operator who knows the capabilities of the software which will be used to create the list, can offer valuable suggestions. Other list owners on the campus can also prove to be valuable resources at this stage. But the final decisions have to be made by you, the future owner of the list.

When you are ready to ask the system operator to set up the list, be very specific about the features you want your list to have. Being very specific about the features you want will prevent a situation similar to the one mentioned earlier about the loss of a few weeks' messages because of the optional archival feature not being activated when the list was set up for use by students in this author's classes.

Maintaining the List

Once a discussion list is created, it pretty much functions automatically. If the list is unmoderated, as is the case with the list owned by the author, all messages sent to list are distributed automatically to the subscribers. If the list is a moderated list, then the list owner has the option of screening messages for length, appropriateness, offensiveness, or other attributes before copies of the same are sent to subscribers.

The system operator who created the list will take care of any other routine maintenance that needs to be taken care of. If problems arise, the list owner should inform the system operator who will take care of them. The owner can concentrate her or his efforts on training students to make good use of the list.

What's Next?

Once the discussion list has been established, the next thing to do is to obtain accounts for all students enrolled in the class for whose use the discussion list was set up. Paperwork to obtain accounts may have to be completed a week or two before the beginning of each semester to ensure that all student will have accounts which they can use as soon as the semester begins.

A computer lab has to be reserved for at least one hour and preferably longer during the first or second week of the semester. This will also have to be done a few weeks before the beginning of the semester to ensure that a lab is available when it is needed. The lab should ideally be large enough to accommodate all students who are enrolled in the course.

Training Students to Use the List

Before taking the students to the computer lab on the designated day and time, students should be given an overview of how to log on the campus computer system, how to log off, how to read and send mail messages, how to delete mail messages, and how discussion lists in general, and the discussion list which has been set up for the course in particular, work. It helps to give students simple, brief, and step by step written instructions to get them started.

In the lab, each student should ideally have access to a computer terminal. If that is not possible, then pairs of students can take turns to work on the computer. One student can work on the computer and the other reads the instructions to her or him. Once the first student has successfully subscribed to the list, then the second student can use the computer, and the first student can the read the instructions to the second student.

Unexpected and unanticipated problems are more than likely to arise in the lab. One semester the author discovered that even though there were enough computers in the lab for all students, some of them were not able to access the mainframe computer in spite of repeated attempts. Later on the author found out that there was a limit on the number of computers in each lab which could be used to access the mainframe at the same time. Once that limit was reached, students using other terminals will be unable to access the mainframe. They will have to wait until some of their classmates logged off the system. Another semester, students were unable to subscribe to the list using a piece of software which is menu driven and which provides on screen prompts, thus making it easier for them to subscribe to the list. It was later discovered that when the class accounts were generated, the accounts were not granted the privilege to access and use the software in question. The author had to show the students another way to subscribe to the list.

Once students successfully subscribe to the list they should be given an opportunity to practice sending messages to the list. Experience has shown that an hour's time in the lab is sufficiently long to ensure that about thirty students subscribe to and send a message to the list. When students send messages to the list, they also start receiving them, and this provides a natural opportunity to teach them how to read and delete messages.

Questions which come up later, when students have started using the list on a regular basis, can be dealt with electronically. Students are encouraged to send e-mail messages directly to the author if they need additional help or if they are experiencing problems. The author can respond to these messages either by sending a message directly to the student, or by sending a message to the list if the response is likely to be of help to more than one person. In the past, students have asked questions about printing messages after reading them. Since the likelihood of more than one student being interested in this information was great, the author decided to send a general message to the list.

Students who need extra help are also encouraged to meet with the instructor either individually or in groups, and use the instructor's office computer to access the mainframe and learn how to send, read, and delete messages, or other things which they wish to learn related to the mainframe or the discussion list.

Some Thoughts About Using a List

The author's students are all elementary education majors who are studying to be elementary school teachers. Once they get jobs as elementary teachers they can use the Internet and its resources to further their professional development. The experience with the discussion list in the author's course enables them to become comfortable and familiar with using technology to exchange ideas and information. Once they become classroom teachers, they can join other discussion lists to interact with their colleagues across the country.

Since students in this author's course are allowed to choose from a list the assignments which they wish to complete to earn their grades for the course, not all students choose to participate in discussions on the list. However, since all students who are enrolled in the course and who were present on the day the class was taken to the computer lab subscribe to the list at the beginning of the semester, all students receive all messages sent to the list. But it is not known how many of the students who do not choose this as an assignment for the course actually read the messages. However, the students who do choose to complete this assignment end up getting a lot of ideas and information by the end of the semester.

Participation in discussions on the list ensures that students communicate with each other and learn from each other outside the confines of the classroom. When they become classroom teachers, they will hopefully provide similar opportunities to their own students.

An added advantage of using a discussion list in a course is that since students already have computer accounts, they can send messages directly to the instructor if they have any questions related to the course. Some students have even submitted their assignments electronically by sending them directly to the instructor's e-mail address.

A major limitation to using a discussion list in a course has to do with the length of a semester. Just when the students become quite comfortable with the notion of discussing ideas and sharing information with each other electronically, and when they become quite proficient in doing so, the semester comes to an end.

In conclusion, after having used an electronic discussion list in a course for more than a year, and based on informal feedback from his students, the author can honestly say that it has provided a positive learning experience for his students.

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LabNet: An Electronic Forum to Support Teaching Science

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Education reform efforts have recently been focused on creating environments for teachers to have greater and more substantive opportunities for professional collaboration (Little, 1993; National Research Council, 1994). It is often noted by educators that teachers rarely have opportunities to reflect on their professional experiences and subject-based learning within the present configuration of the school day (Gal, 1992). Teachers lack both the time and opportunities to reflect on their work experiences, and often, like many other professionals, lack the skills to do so (Argyris & Schon, 1974; Schön, 1983; Argyris, Putnam, & Smith-McLain, 1985).

Effective professional development needs to provide teachers with opportunities to reflect on their teaching practice with other teachers and educators in an ongoing way. Yet, such opportunities are often not emphasized in teachers' professional life (Grimmett & Erickson, 1988). Because discourse can occur asynchronously, educational telecommunications networks are one way for teachers to collaborate professionally, share resources, and have a forum for communication that is responsive to their hectic schedules. There are an increasing number of networks being created for professional discourse; however, little is known about the uses and impact that computer-mediated communication (CMC) have on professional development.

Very few studies have addressed the question of the purposeful use teachers make of telecommunications from the teachers' view point and actual experience (Bruce & Rubin, 1992; DiMauro & Gal, 1994; teacher essays in Ruopp, Gal, Drayton, and Pfister, 1993 and in the *Journal of Research in Rural Education*, 1993; Newman & Torz, 1990). Until now, the greatest focus on the use of educational networks has been to enrich student learning. Yet, using networks to support and publicize professional collaboration and reflective practice in teaching is an important, but overlooked domain for network use. Educational networks hold a unique potential for breaking geographical barriers, sharing resources, and offering teacher-teacher collaboration for professional growth. So far teacher-teacher collaboration research has been limited. Therefore, one question that has important relevancy for the educational - technological community is:

What types of learning experiences for educational collaborations can be offered on a telecommunications network?

In this paper, which is an abridged version of a longer research study, we present an analysis of a LabNet network conversation in which teachers explored how scientific theories are developed and how their own knowledge of theories in science influences their science teaching. In particular, we focus on the nuances of the conversation, as teachers share ideas and beliefs about their science, teaching, and the philosophy of science. Unlike traditional teacher talk, which normally takes place in the teachers' lounge and, by virtue of teachers' hectic schedules, is typically hurried and fragmented, this conversation occurred over an extended period of time among five teachers in various locations in the United States. And, perhaps more notable is the unusual nature of their conversation, in that teachers explored their beliefs, reflected on their own learning, looked at shortcomings of their classroom practices, and considered their interdisciplinary understandings of scientific notions.

Breaking Barriers in Teacher Talk

This case study is drawn from a two-year research study of the LabNet network. In this section, we establish the context for the case study, the nature of the network dialogue, and our methods of analyses.

The LabNet Network

During the past two years the LabNet II project has designed a telecommunications network, with and for K-12 science and math teachers. Together we have created a variety of experiments to test what features of network-mediated discourse promote a community that supports conversations about science and teaching science. The network itself is composed of several areas, each of which serves a somewhat different function. The library has such information as articles from periodicals and journals and archived LabNet conversations that teachers can download. Topic areas are designated for physics, biology, and chemistry along with several other interest areas, and collaborative projects. The community forum is composed of folders that address both science and non-science issues that teachers face. Working groups are designed for groups who work together on particular topics, like curriculum or network leadership.

Each of these areas, designed jointly by LabNet staff and teachers, has several folders that address more particular issues about a particular topic. Individual teachers and, in rare cases, staff open folders to begin a new discussion. Once a folder is opened, others may join the conversation by posting messages in this same folder. What this means for network use is that the thousand teachers currently on the LabNet Network can join one of hundreds of existing conversations or begin new folders on topics that are of interest or concern to them. This is important to keep in mind when considering any one particular conversation on the network, for even though a small number of teachers may post messages on a particular topic, many other teachers may read these public messages or post related messages in other folders.

Methodology

We believe that computer mediated messages (CMC) extracted for analysis from a folder on the LabNet network are best considered both from the micro-conversation and the larger network forum so as to give an overall perspective of the conversation. Because we are examining LabNet discourse to find out how teachers have used the medium to talk about science and pedagogy, we select smaller segments of network discourse for more in-depth analysis. Selecting a conversation for analysis requires a small enough segment that is conducive to a careful examination of the content and conversation dynamics, while at the same time of enough length and duration to assess the development of an idea. On one folder there may be multiple conversations with natural beginnings and endings, just as there is an ebb and flow of topics in any face-to-face conversations. We usually observe a shift in a network conversation when one message triggers a new line of thought and subsequent messages refer to this new idea instead of the previous topic.

We used two criteria in selecting network conversations about science. First, the conversation is sustained; that is, there are at least 10 messages and four participants with the conversation lasting at least three weeks. Our analyses of previous network conversations suggests that these parameters are the minimum required for network discourse to develop a single idea. The second criteria requires that the conversation is primarily about a topic in science and that there is substantive information in the conversation. There may be references to teaching in any of the messages, but the primary intent of the discourse is to consider an idea in science.

Conversation on the Nature of Science

The conversation we selected for our analysis, *Against Method*, is from the community forum, the LabNet area that teachers use to explore ideas in education that may be either directly or indirectly related to science or teaching science. We selected the conversation from the issues in education folder on the forum. This folder has been active for 19 months and includes over 120 messages. It is a folder in which teachers grapple with the social, psychological, and cultural aspects of teaching. And, it is sometimes a place on the network in which teachers reflect on the nature of science and how we come to know and understand concepts in science. The conversation fit our selection criteria in that it was a sustained conversation about the nature of science that took place over a six-week period, had five participants, and 18 messages.

Analysis and Interpretation

Throughout the network conversation, *Against Method*, the teachers shared their understanding of the scientific method and its relationship to both their own learning and teaching. Teachers had diverse opinions and beliefs about the relationship among theory, experimentation, and data in developing scientific theories. What became evident to the participating teachers was the fact that scientists used no one way to conduct scientific inquiries. The "scientific method" was not a static methodology but rather as individual as each scientist. Teachers discussed *Against Method*, Feyerabend's book (1975) which explores the nature of science and knowing. Drawing from their own experiences as both learners and teachers they used the discussion to corroborate or challenge their own notions of scientific practice.

There are several perspectives one can take in analyzing the conversation *Against Method*. For example, several teachers referred to insights about their own understanding about the nature of science, which we call a personal learning perspective (DiMauro and Muscella, 1994). The science content in many messages referred to the development of particular scientific theories or to authors who have examined the hermeneutics of scientific knowledge. The message titles in this particular conversation changed throughout the discourse, acting as subtitles for the concepts that developed during the dialogue (DiMauro and Muscella, 1994). Finally, there is the impact that particular messages had on the conversation. Some messages were never referred to in subsequent messages while two particular messages stimulate well over half of the messages that are posted during the course of this conversation.

Discussants raised issues about their skepticism with "traditional,", stock notions of how science methods are practiced. In this cases analysis of the network conversation, we focused on the factors that stimulated and sustained a conversation about science. We first examined the messages that seemed most influential in the promoting discourse and then examined what about these messages provoked the lively discussion that ensued. We consider two factors in our case study of this conversation: those that stimulate a conversation about the substantive issues in science; and the content and nuances that prompt the participants to develop the themes of the discourse.

The Impact of Messages

There were 18 messages in this conversation. Some messages, like Jay's and Colleen's provided the foundation for the subsequent discourse and two others written by David Hammer acted as a stimulus for the conversation, provoking people to explore ideas in more depth. Table 1 shows the number of times to which each of the 18 messages were later referred in the conversation. We consider a direct reference as one in which a participant directly remarks on some particular aspect of a previous message. An indirect reference is one in which sender expands on the theme or content of a previous message, without necessarily alluding to any particulars of the message. Because the first and second messages, *What science leaves out* and *The Dance*—messages posted respectively by Colleen and Jay and the fourth and eighth messages—Re: *The Dance* and Re: *Against Method*, both by David—were used as referents in many more subsequent messages, we conducted an analysis of the internal content of these messages. Upon completing this analysis, we then examined how these messages' influenced the discourse. Our analysis suggests that the content of Colleen and Jay's messages stimulated others to respond about the nature of science. On the other hand, David's messages grounded the conversation in scholarly perspectives about the nature of science. We argue that both kinds of messages are necessary for network conversations about substantive issues in science.

Table 1. Messages and Their Subsequent References in the Conversation

Message Title	Direct Reference	Indirect Reference
What science leaves out	2	1
The dance	2	0
The Dance/The Joy	0	0
Re: The Dance	2	4
Against method	1	0
Method?	1	0
Re: Against method	1	0
Re: Against method	3	3
Galileo, et al.	1	1
Re: Galileo, et al.	0	0
Re: Galileo, et al.	0	1
Mucking around	2	1
Re: Mucking around	1	0
Re: Mucking around	1	0
Muck II	0	0
Re: Mucking around	2	0
Re: The right way	0	0
Re: Muck II	0	0

What Factors Promote a "Good" Start

Colleen, Jay, and Andrew, who are the first contributors to this conversation, each provide the impetus for others to participate. In late April 1994, Colleen began the conversation by sharing her reflections about pro forma science and science that advances bold, new frontiers. There are three elements in Colleen's message that invite others to participate, each element an honest appraisal of her knowledge, beliefs, and puzzles (*What science leaves out*, Colleen, 94-04-25). First, she shares her puzzlement about science:

> *When you talk about the scientific method and objective, verifiable truth, I sense a certain sterility. But I don't think that the foundations of science as we know it, the theories, were conceived in this barren context....Every bold new advance had its roots in a fertile imagination....*

Colleen explores this idea further by describing a personal learning experience, which occurred as a high school math student and was her first glimmer of what scientific discovery is about:

> *....it reminds me of when I was in 10th grade trying to learn geometry. For six weeks, I did everything I was supposed to do methodically step-by-step....I was basically clueless as to the big picture....Then one day I picked up my book and turned back to the first page and began to read. All of a sudden things fell into place....*

Colleen ends her message with a metaphor that both provides an image for the relationship between theory and data, while at the same time leaving enough unsaid about the metaphor so as to prompt later discussions it:

> *Science can be taught....as a lifeless collection of laws, facts, and relationships, or it can be revealed as the dynamic process....Every year I try to move a little further.... along the path (of the dynamic process)....but I can only do this as my own understanding of the "dance" grows....*

By describing the relationship between theory and

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verifiable data as the "dance," the metaphor becomes central to the next three messages. Jay, after reading Colleen's message defines the metaphor of the dance (The dance, Jay Fogelman, 94-04-26). :

> *Theory dances around and through the experiment, and vice versa.... The constraints of acting within the bounds of data and models actually requires a thinking and rethinking, which is joyful.*

Andrew gives more substance to the metaphor by when he described how the theories of waves and particles began to manifest itself in his everyday world (Re: The Dance/ The Joy, Andrew Njaa, 94—4-27):

> *...the joy of discovery came for me when all of a sudden I saw the motion of the turntable as just another perspective of the motion of the pendulum. After that, I looked for waves everywhere...*

It was David who capitalized on the personal reflections and the metaphor of the dance to bring the conversation to a discussion about how particular theories in science are developed.

Keeping it Rich and Interesting

In David's first message, he refers to Paul Feyerabend's book, *Against Method*, about which Colleen and Andrew ask for more information. David does not, however, simply report the main findings of the text impartially. Rather, he raises the controversial issues that Feyerabend addresses in his text, and does so in a way that provokes responses by employing language to which others will inevitably react (Re: Against Method, David Hammer, 94-05-16).

> *Feyerabend uses Galileo to talk about all of the rhetoric and manipulation, and trickery he did to get us to believe him, and it is a mistake to think he was impartially observing the world, making hypotheses and drawing conclusions. According to Feyerabend, much of what Galileo was claiming to be true was shown to be false by experimental results....In the end, it was very productive to Galileo to be so unmethodical in his work.*

David's message sets the stage for the discussion that ensues about whether scientific methods should be as methodical as some scientists purport. David furthers the discussion by claiming there is no real scientific method (Re: Against Method, David Hammer, 94-05-16):

> *I don't know whether I can do the book justice, but the basic idea is that there isn't any "scientific method," and we shouldn't expect there to be. If you really look at what scientists do, it isn't very methodical.*

A few messages later, David then describes how Feyerabend and Bruno Latour's book, *Science in Action*, have influenced his thinking about the relationship between theory and data (Re: Galileo, et al., David Hammer, 94-05-21).

> *...one of the things that reading Feyerabend...has done for me is made me more humble about any ideas I had that I know precisely what scientific reasoning should look like.*

David's references act as catalyst to the conversation and validate teachers' personal perspectives in the discussion. Only a few hours later, Richard, another teacher, evokes Feynman in efforts to support David in his questioning. And additional references are made by others to scientists and philosophers such as Galileo, Newton, Schwinger, Schrodinger, Heisenberg, Keller, and McClintock.

Discussion

What causes any one message to stimulate much of a network conversation? Addressing this question has important implications for any electronic network designed to promote professional development of teachers. If we have a better understanding of what promotes and inhibits reflective conversation, we are in a better position to support such conversations on a network. Perhaps, more important, understanding what prompts reflections on science and science teaching will allow teachers, teacher educators, and teacher researchers to create the conditions conducive for reflective teaching.

In the conversation, Against Method, each turn in the discourse further develops the theme. By skillfully bubbling between the philosophical and the pragmatic world teachers are able to ground their discussion without letting go of intellectual pursuits. The role of reflection on one's own learning proves to be as important as the role of the provocateur, a role that David plays. David is a science educator at a university in the Boston area who works with the LabNet staff and teachers. He has self-selected two roles for himself on the network. One is to use the network with his undergraduate students and the second is to stimulate interesting discussions about teaching and learning science on the LabNet network. It is clear that David is knowledgeable about the nature of science, physics, and learning science. In this conversation, David considers his knowledge about science in light of the teachers' personal reflections about their own learning. This synergy between experience, self-knowledge, and theory seems a critical aspect for promoting a conversation about science. Without David's references to research and the philosophy of science, the theme of the conversation may not have developed. And, yet, without the stimulus of the personal reflections of Colleen, Jay, and Andrew, the discussions of theory would most likely remain unfocused.

If we can develop and sustain electronic networks that provide opportunities for teachers to learn new content in science and have support from colleagues as they experiment with pedagogy, then we will have moved professional development forward in the United States. Our research suggests that an electronic network promotes a community of practice in which teachers work together as colleagues, using an electronic forum in the service of making changes in their teaching practice. There remains, however, much to be explored about the best use of electronic networks that support reflective practice.

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Young Engineers and Scientists: A Mentorship Program Using Information Technology

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Southwest Research Institute (SwRI) hosts the Young Engineers and Scientists (YES) mentorship program instituted in 1993 in applied physical sciences, information sciences, and engineering for high school juniors and seniors living in San Antonio. The aim of YES is to increase the number of students, including females and minorities, seeking careers in these fields and to enhance the participants' chances of success in achieving their career goals. The program is divided into two parts: an intensive 3-week group training session held at SwRI in the summer where students are paired with SwRI staff members on a one-to-one basis, and an individual mentorship project completed during the academic year in which students earn credit at their high school.

The YES program had 20 participants during its first year (1993-1994) and presently 22 students are enrolled for the current academic year (1994-1995). Several students have completed or are currently working on projects in the information sciences (e.g., computer communications, virtual reality, fuzzy logic, artificial intelligence, graphics programming, etc.). In this paper, a brief description of the YES program is given, and the use of information technology and its specific effects on teacher education is highlighted with examples from the summer workshop and independent student projects.

The Goals of YES

The primary goal of YES is to encourage talented students to pursue science and engineering majors in college; first, by expanding career awareness including information on "hot" career areas through an increased presence of working scientists and engineers in local high schools and, secondly, by allowing students to interact on a continuing basis with role models at SwRI. SwRI staff members, including females and minorities, recruit YES participants from local high schools by presenting talks and slide shows about their ongoing research projects. These presentations are given on a volunteer basis. During the academic school year, displays and presentations of the participants' work in the local schools increase the benefits of the YES program by spreading career awareness to other students and teachers. The summer program and the academic year mentorship provide the students with a wide variety of role models, including a large percentage of women and ethnic minorities.

The secondary goal of the YES program is the retention of good candidate students in applied physics, information sciences, and engineering programs. These are the fields in which women and minorities are most underrepresented (Benditt, 1992; Pool, 1990). To address the problem of retention, YES emphasizes networking among peer students and mentorship between students and professionals already established in the field. Mentorship is recognized as a necessary component in professional development (Gibbons, 1992; White 1970) and acknowledged as a critical component of development programs for gifted and talented students (Beck, 1989). The importance of a peer support group is also widely noted (Council of Ontario Universities, 1988; American Association of University Women, 1992).

The educational benefits of the YES program are multifaceted and impact students and teachers as well as the community. During the summer program, the students develop computer and mathematical skills necessary for solving research problems and learn the fundamentals of electronic circuit design. Students attend career exploration seminars on various research areas at SwRI and participate in discussions on scientific ethics, the social impact of technology, and the funding process. Training in time management, library resources, and public speaking are also given. During the school year, students work individually with their mentors on their independent study project which is closely monitored by their independent study/mentorship (ISM) teacher. At the end of the school year, students present and display their work in local schools, acknowledging their accomplishments and spreading career awareness to other students and teachers.

During the course of the school year, YES participants are also required to make presentations on science and engineering as career options to the larger community. For example, a student might meet this requirement by co-presenting a talk on electrical engineering at a local elementary school Career Day with her mentor. Another option might be to sell prototypes of a puzzle designed in the course of the mentorship in the student store at her high school. Beyond the lasting benefit to the students, more mentors are cultivated for the future.

Teacher Participation

Throughout the school year, teachers of the independent study course (ISM) in the local school district are closely involved with the YES student's research and product development. These teachers are able to observe first hand the movement of a student's learning from a knowledge and understanding level to real world application. The teacher learns what part of the school curriculum best supports the needs of a student preparing for a career in scientific research and engineering. In the one and one-half years that the program has been developing, there have been several instances that exemplify how teachers are willing to change in order to help the students more quickly function in a real world situation. Several of these examples demonstrate how information technology has influenced teacher education. Three specific cases are summarized below.

Keeping up with current trends in computer languages in one area where YES students have brought knowledge from their independent study experience to their classrooms. A computer science teacher at one of the high schools involved with the YES program is learning the C/C++ programming language with the help of the YES students in her class. This is in addition to the Pascal language that she has traditionally taught because her YES students are required by their SwRI mentors to program in the C/C++ language in their independent study projects. The teacher is now studying ways in which this new knowledge can be incorporated into her computer science classes.

Drafting is another area where computer technology has recently made a major impact and where the interaction between the YES program and teacher education has resulted in cross fertilization. A drafting teacher at another high school participating in the YES program is updating his knowledge of computer-aided design (CAD) which his YES students are using in their independent study projects. One of the students is designing a hover craft and is doing most of the planning on state-of-the-art CAD software at SwRI. This has resulted in an increase in demand from his other students to learn more about state-of-the-art CAD systems. He is studying methods to bring this information technology into his classroom.

In addition, the ISM teachers are becoming more familiar with electronic computer networks since their YES students are wanting quicker and more in depth access to information for their research projects. Many of the YES students use electronic mail as the method to keep in regular contact with their mentors at SwRI. Modems for high school computers have been installed so students can access popular periodicals for background information as well as primary information at a variety of Internet sites using the World Wide Web software. The teachers have become involved with this activity and are learning how best to use these resources for their benefit as well as for their classes.

Because some of the work required of the students through the YES program is not best supported by traditional library research, teachers of independent study are providing the opportunity for students to learn by other means, such as trial and error experimentation, personal interviews of SwRI staff members, and observation of staff members' research. Documentation of the student's learning is maintained in a research portfolio which is monitored and evaluated by the ISM teacher and the SwRI mentor. Both the teachers and the students are learning together, with the student guiding the teacher to what is best needed for their real world experiences at SwRI.

At the end of the school year, other teachers, students, and members of the community are invited to a final presentation to see the student's product and hear of their investigation through a formal speech. These presentations have been influential in motivating participation of more students for the next academic year. As a result, twice as many applications for the YES program were made the second year of the program. An important area of expansion for the YES program is to provide more opportunities for high school teachers to participate in the student-mentor partnership in future years to enhance the impact of information technology on the education of teachers involved with YES.

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PRESERVICE TEACHER EDUCATION

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As the title implies, the articles in this section of the Annual focus on efforts of colleges and universities to integrate technology into the preservice education of teacher. This section reflects the commitment of centers of learning to prepare personnel with knowledge and ability to infuse technology into curriculums of our K–12 schools. Over the years of this publication, the editors have noted the growth of ideas spawned by this commitment and the progress toward meeting important technology–related goals. The comprehensiveness and depth of efforts increases each year as the community gains and refines experiences. In this year's collection of professional papers the topics cover a rich range from learning about computers and computer tools to using computer technology to explore alternate ways of delivering teaching and learning. Eight of the papers submitted focus on *general or programmatic efforts* by individuals and institutions to provide opportunities that enable preservice teachers to develop an understanding computer technology conceps and acquire related skills and abilities. For the first time this year the largest number of papers, thirteen, focus on the *integration of technology throughout the teacher education curriculum.* This is not to say that none of the programs described in the first section don't include such efforts. Our last and smallest category contains three papers that involve *instructional technology and alternative models for teaching and learning*. Those of our readers who have been involved in technology and education and have a sense of its history will appreciate the gains over time that are reflected in these papers.

General and Programmatic Efforts: Instructional Technology in Teacher Education

Davenport of St. Mary's University and Dickey & Dickey of Eastern Kentucky University have all written to tell us about how matters are being pursued at their respective institutions and what lessons they have learned. Similarly, Boston & Kay of the College of St. Mark and St. John, and Taylor at the University of Exeter write about their efforts in England, also providing us with insights into the English teacher preparation system.

In the reality check department, Austin, of the Francis Case School in South Dakota, tells us of her experience going from college instructor to second grade computer teacher. Her analysis of how well what she used to teach teachers about technology works in the real world are of value to us all. To sum up this section, Vagle of Drury College presents his survey and analysis of the practices of "exemplary" teacher technology education programs.

Integration of Instructional Technology Throughout the Teacher Education Curriculum

To begin this section, we again present work by Vagle of Drury College: this time his survey and analysis of the state of the integration of technology into teaching methods courses at "exemplary" institutions. We think that Vagle's findings set the stage for the rest of these papers on the subject.

Wentworth & Breithaupt of Brigham Young University describe their use of Hyperstudio in a secondary education curriculum course to ensure that preservice teachers learn about the computer as a tool both for managing instruction and for enhancing instruction. Downs, Clark, & Bennett of Georgia Southern University and Ouyang of Knnesaw State College relate the integration of technology into curriculum and methods courses. Schmidt, at East Carolina University, presents the first paper that we can recall seeing in this section on integrating technology into the music education curriculum.

In the laserdisc arena, Stephens, at the University of Houston, tells us about her efforts in designing, developing, and evaluating a laserdisc for English/language arts teacher education. Similarly, Riley & Martin of the University of Montevallo have developed a laserdisc for use in elementary mathematics education methods courses. Nath, also of the University of Houston, describes repurposing videodiscs to teach effective teaching behaviors.

Lumpkins, Rayborn, Herrin, & Parker at Henderson State University conducted a study gathering data on children's experiences with technology in early childhood programs and in preschool settings. McCraw & Meyer of the University of Southern Indiana then follow up by telling us what teachers need to know about appropriate uses of technology in the early childhood curriculum.

More and more institutions are beginning to look at using technology in field experiences. Stulmann, Taylor, & LaHayeat Louisiana State University used technology to provide authentic learning experiences for preservice teachers by pairing them with fourth graders to develop technology-based language arts. Zambo, Wetzel, Buss at Arizona State University West describe their efforts at implementation and evaluation of their results in finding innovative ways to integrate technology into student teaching experiences.

A key issue in integration, of course, is faculty development. We think it appropriate, therefore, to close this grouping with Kortecamp & Croninger's paper about their model for faculty development at the University of New England.

Technology and Alternative Models for Teaching and Learning

Byrum & Leavell, at Southwest Texas State University, describe the development and use of a technology-based hypermedia portfolio for evaluation of preservice teachers. White, of the New Mexico State University, describes the place for technology in a constructivist teacher education model and Silvennoinen of the University of Jyvaskyla in Finland discusses an alternative to lecturing in a teacher education program for preservice students in physical education.

In conclusion, we think that you will enjoy these papers as much as we have. We hope that you will join us in looking forward to the submission next year of a paper on the use of relative word processing formatting skill as a summative measure of success in doctoral studies.

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Let the User Beware

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Problems and frustrations abound in the introduction, implementation and evaluation of technology into teacher certification classes and field based experiences at St. Mary's University, San Antonio, Texas, and its partnership schools in various independent school districts in the area. The education department of St. Mary's University is a participating member of a local collaborative made up of the five institutions of higher education, the community colleges, the region service center, and the local school districts. The collaborative, the Center for Educational Development and Excellence (CEDE), is funded through competitive grants by the Texas Education Agency on a decreasing scale which is entering the third year. Future efforts must be institutionalized or funded by outside means. Implementing the uses of technology with the goal of improving educational quality has led to partnerships for cooperative efforts by university faculty, preservice teachers, practicing teachers, administrators, and the region service center staff.

The Problems

The first requirement for the successful implementation of the use of technology was the training of teachers at all levels. This proved difficult for several reasons. First, teachers were "afraid" of the new and unknown. Bennett and Bennett, 1994, found that teachers "are overwhelmed with the prospect of not only having to learn to use the machine themselves as well as learning how to integrate the use of it into their instructional repertoire....Typical coping strategies used by teachers in this situation include leaving the computer unplugged and covered up in a corner of the room, telling students it is broken, or letting students use it as an arcade-type amusement."

Secondly, most teachers were basically happy with the way they were teaching and saw no need to change. "Throughout the history of American education, the process of teaching and learning has been a solitary endeavor...with the teacher being the giver of knowledge and the student being the passive receiver of knowledge" (Beacham, 1994). John Goodlad (1984) has described the teacher's work environment as "the closet of the classroom". We teach as we were taught, therefore, teachers rarely see examples of technological integration into the curriculum after which they can model their own teaching. Until teachers are trained and shown how to use technology in their teaching, the integration will rarely occur.

The third block to getting teachers trained to use the technology was that teachers were reluctant to leave their classrooms to get training. In a state where teaching/ learning success is measured by a test mandated by state legislature, teachers do not want to entrust their students' learning opportunities to a substitute teacher. Many said such things as "If I'm going to be held responsible for the results on the test, then I must be there to be sure that my students receive the training they need in order to do well on that test."

The second requirement for the successful implementation of the uses of technology was that the uses of technology be modeled for the preservice teachers and that they be trained to use it when they become full time classroom teachers. This proved difficult because the university faculty was often far behind the curve in being able and willing to do this. Beaver (1990) stated that much of the problem in undergraduate educational technology is the higher education faculty themselves. He stated that a void exists in the training that the faculty received and this void is passed on to their undergraduate students.

The third requirement for success was to have equipment and software that was appropriate for use in the classrooms so that teachers could use and integrate it into their daily lessons. Knowing what to buy and how to evaluate it proved to be very difficult. As Dorothy Smith (1994) reported, the motto for St. Mary's collaborative might be "**Beware of Experts!**" It proved difficult, if not impossible, to find those who could provide expertise in presenting materials that were consistent with the objectives of the courses for undergraduates at St. Mary's. We found that either the software was not appropriate for the course or the implementation of it was so complicated that professors were reluctant to employ it.

The fourth requirement for success was that the technology available to the university and its partner schools be put to use in new and creative ways. This proved difficult because the simple mechanics of getting everything working the way it should was beyond the expertise of the university faculty members and required a great deal more time than was available. Often it was found that the "experts" in the field were unable to make things work the way the teachers thought they should. Many times the equipment simply failed to work. The various software programs proved incompatible and caused difficulties with the hardware.

The two years that we have been working on this project have proved to be extremely stressful and frustrating. When new applications have been attempted, productivity has gone down. Teachers often comment that there is "not enough time to teach a regular course and do technology, too."

However, when things do work they are very exciting and rewarding and much has been learned that can be useful to those beginning the work.

Lessons Learned

1. No matter how simple you make change, some people will be reluctant, if not totally resistant, to it.
2. You can teach an old dog new tricks, but it is extremely difficult.
3. Getting people trained is only the beginning step.
4. Getting people trained is difficult.
5. Districts have their own agenda and it does not necessarily match the agenda of a collaborative effort.
6. The "experts" do not always have the answers.
7. The "experts" do not always share important information.
8. Modeling the use of technology is vitally important to the integration of it into the curriculum.
9. Expect productivity to decrease during the learning period.
10. Always have a contingency plan.
11. Always have a back-up plan for use **when** (not if) the technology fails to operate correctly.
12. Keep asking questions.
13. Keep trying.

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Preservice Teacher Computer Literacy and Performance Assessment

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Early, middle, and secondary teacher certification requirements in the state of Kentucky require teacher education institutions to incorporate instruction in computer literacy, application, and operation. Further, proficiency in this requirement may be achieved through formal instruction, or, at the option of the teacher education institution, may be demonstrated by an appropriate evaluation of proficiency and shall be prerequisite to methodology courses (Office of Teacher Education and Certification, 1994). This paper describes a computer information systems course offered at Eastern Kentucky University.

Eastern Kentucky University has determined that all candidates for admission into the Teacher Education Program for the above mentioned certification programs must meet the computer literacy requirement (College of Education, 1994). Candidates must satisfactorily complete a written and hands-on computer literacy test or obtain a grade of "C" or better in a computer course. There are several courses from which to choose. One of the courses, Introduction to Computer Information Systems (CIS 212), was developed in a cooperative effort with the College of Business. The information presented in this paper explains the basic elements of this computer literacy course and how performance assessment is being used in the student evaluation process.

Performance assessment is evaluation of students based on their creation of a product or answer (Feuer & Fulton, 1993). Assessment procedures would not only include evaluation of the student's knowledge base, but would also include projects that require application of that knowledge through performance. Peformance assessment is authentic assessment when such projects both mirror and measure student performance in real life tasks and situations (Hart, 1994). In such an approach, students would be evaluated based on projects closely associated with actual computer practice.

The Computer Literacy Course

Introduction to Computer Information Systems is directed toward general computer literacy. Its students come from a multitude of academic majors from many different colleges. The students exhibit extreme diversity of readiness for the course. This heterogeneity requires an approach that orients the less prepared students, while readying the preparedness of other students for advancement into the topics of the course. For this purpose, the order of process of student instruction is (1) orientation to the hardware, (2) system operation, (3) skill development, (4) performance based evaluation, (5) knowledge base development, and (6) testing of knowledge base development. This order is noteworthy since hands-on experience leads the development of a student's knowledge base. Practice has shown that lecture is most effective when it follows both hands-on experience and performance assessment.

To conduct the course, the instructor uses both a laboratory arrangement and a traditional classroom. The laboratory arrangement uses a dual display with a computer monitor and an overhead projector display panel (VGA).

Items 1 through 3 in the order of process explained above depend critically upon this arrangement. The instructor teaches by example, with the students duplicating on their own computers the examples they see on the instructor's display. This allows immediate reinforcement of the concept with experience. It is a natural orientation for both the course and its textbook (Martin and Parker, 1995).

The student is oriented to the hardware with emphasis on the mechanical interface, i.e. the keyboard, the video display, the mouse, and the printer. The order of software topics is MSDOS, WordPerfect, Lotus 123, and dBASE. The perspective of the instruction treats each particular application program as an example of the general type of program it represents. Within each topic, the student is led through a series of examples climaxing in a project drawing upon the skills engendered by those experiences. The performance events include (1) using DOS commands to write a batch file program to run various application programs conveniently, (2) using WordPerfect to create a personal vita, (3) using Lotus 123 to create a personal budget analysis with automated calculations and report generation, and (4) using dBASE to create a contact management database. In each case, the student is directed to produce a working product that can serve a genuine need. Rubric based assessment of the performance projects creates a component of authentic assessment that can better determine each student's ability to operate and apply computer competencies.

Upon the completion of the laboratory experience, the students return to the traditional classroom for development of their knowledge base through lecture. This development is assessed through traditional testing methods. In this process, the students draw on their project and their other hands-on experiences to provide a personal perspective from which to expand their knowledge base with much greater success than would otherwise be possible. Laboratory experience, performance projects, classroom instruction and testing are all coordinated to assist the students not only in acquiring knowledge but also in applying computer skills.

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Helping Strategies on the Slippery Ladder to Competence and Confidence

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The College

The College of St. Mark and St. John, affiliated with Exeter University, has approximately 2000 students; about half are either B.Ed. or PGCE (Post Graduate Certificate of Education) students, and the rest are B.A. students. The college itself, once a simple teacher training facility, has grown to become a college offering a wide range of higher education provisions, both at the undergraduate and post-graduate levels. Included in its offerings are initial training courses for primary and secondary teachers. Intending teachers may undertake a four-year, B.Ed. Honors course or, where appropriate, a one year Post-graduate Certificate of Education.

The Course

The two main subjects for intending secondary teachers are Design and Technology and Physical Education. Educational Information Technology (EIT) is one of a range of subsidiary subjects offered to PE students. B.Ed. courses have three components. The students are educated in their subject specialties, provided with pedagogical training in their subject area, and come together on the various generic courses for those aspects of professional training that are not subject-specific.

Those elements where the students come together from the various subjects to study topics of relevance to all teachers are called Context Studies. Education studies within the B.Ed and PGCE are firmly placed within a philosophy which owes much to Schon and the idea of developing reflective practitioners from the commencement of their training. Eventually, 66% of the students' time will be spent in schools.

The Department

Within the EIT modules, we move the students from inexperience through competence and confidence. There are no prerequisites for taking the modules, and the department prides itself on its record with inexperienced users. Our open access policy to both the hardware and IT staff helps to encourage a friendly working partnership rather than a "them and us" mentality. The end results are students who have the tools to continue their own development independently and provide leadership in this area.

Centre for Information Technology in Education

CITE is the teaching centre for information technology within the college. In addition to their work in the college, CITE staff provide support, both in the UK and abroad, for the development of IT related classroom materials, the production of course materials, and teacher training in IT related areas.

Course	Potential IT Input
B.Ed. Primary	Four one day workshops within Context studies
B.Ed. Primary with IT as second subject	EIT 101/102/201

B.Ed. Secondary PE Main	Three one day workshops within Context studies
B.Ed. Secondary PE Main with IT as second subject	EIT 101/102/201. STS Modules: "Teaching of Information Technology"
Post-Graduate Certificate of Education (PGCE)	Awareness level courses

The rest of this paper sets out in greater detail three of the many activities used to foster higher levels of confidence. The specific examples upon which we will expand are:

1. Students producing small scale multi-media learning/ information packs. (part of specialist EIT module)
2. Using IT students to teach more esoteric features of general purpose software to one another. (part of specialist "Teaching of" IT module)
3. Using specialist IT students as tutors on all day IT workshops for their peers - we call these "IT Big Days". (part of the Context studies programme)

Each of these exemplifies the way in which personal and group exploration can increase both IT competence and pedagogic development.

Small Scale Multi-media Learning or Information Packs

Background

Over the past three years students in both B.A. and B.Ed. programs have used packages such as *Guide* and *Toolbook* to produce small scale learning packages. The assignment demanded that the students use their own exploration of such software to develop a teaching structure which they could later utilize in the classroom. The task set allowed for a true blend of IT enhancement and teaching skill development.

The Task Set

The students were asked to look briefly at 8 pieces of general purpose software and to then choose one for further exploration. They were required to:

1. Explore the full range of functions of the package by going through the manual, using on-screen help, seeking out other reference materials, etc.
2. Identify the conceptual stages of the learner.
3. Explore the potential of the package with regard to problem-solving.

Almost half the students in the group chose one of the two multimedia authoring packages *MMBox* or *Magpie*. The applications used by the students reflected both the hardware and software currently available within UK schools. We felt it important that they choose software which they would be able to use with their pupils. We also tried to keep a sense of balance between technological innovation and network practicalities. The majority developed material consisting of text and graphics only. There are several machines capable of advanced multimedia integration within the college and students who wish to push themselves just a little bit harder may employ these.

Conclusions

The students have found the challenge and stimulation offered by this task a distinct enhancement in developing their ability to formulate a conceptual framework so that they may teach their own pupils how to use this software.

The time spent by many students far exceeded what was expected, which is a measure of the motivational power of such tasks. Many who had spent excessive time admitted that this resulted from their own interest and not from the lecturers' demands. The authors have copies of some of the work produced and viewing is available upon request.

We believe that incorporating the use of authoring and multimedia into our courses has been a successful and popular decision. The students have been introduced to many of the basic principles upon which they can build and develop their own expertise. We are still debating with the problem of the focus given to such work and its place within a comparatively short module. However, because there are eight different packages being used at any one time, we feel that the current model of implementation has considerable advantages.

Main Benefits

There are many benefits to this assignment. Teaching strategies produced by the group are shared and become part of the group knowledge. Because all students are learners in this exercise, a great deal of collaboration on resolving any difficulties is encountered.

Students came to appreciate the freedom they had in creating their own learning aids. The exercise forces very rapid skill development. Those working to produce a multimedia pack see the work as having considerably broadened their IT horizons. Because the exploration of software potential is left to them, they acquire a feeling of control.

Peer Group Teaching

Background

Physical education students taking IT as their supportive subject undergo a program of activities designed to prepare them to take a significant role in the delivery and support of IT across the secondary age, subject and ability range.

From the start of their "Teaching of IT" course, we tried to put the students in a teaching or support situation as often as possible. Toward the end of their first year program, we set an assignment where in small groups students are responsible for teaching their fellow students within the group about a particular feature of a larger package. We chose features which had not been introduced as part of their subject studies and were considered more advanced.

The Task

Students were split into groups of three. Each group was assigned one of the following topics:

1. Databases in Excel
2. Using Macros in Excel
3. Creating a Slide Show in Excel

4. Creating and Using Outlines in Word
5. Creating a Table of Contents & Indexing in Word

In the teaching sessions, each individual in the group taught a topic to three others and was observed by one person. Each student:

1. Delivered a lesson
2. Observed a lesson
3. Was on the receiving end of three lessons

Observations were recorded using the standard college teaching practice observation and lesson evaluation sheet.

Each student had to produce teaching material for a one hour lesson but was only required to perform for 20 minutes. The performance was followed by two five-minute feedback sessions, the first from the observer and the second from the learners. We felt this to be important as it emphasized constructive observations of others teaching.

Reaction

Most students found the exercise stimulating, albeit somewhat nerve racking. Many found it a valuable preparation for the time they were soon to spend in school.

Problems

There were some course problems:

1. Assessment was difficult. The following areas were weighted in grading: presentation, teaching materials, teaching performance, and quality of the reflection afterwards. Assessment was not exact and more specific guidelines and objectives need to be formulated.
2. Difficulty of the material to be taught. The five topics were not of equal difficulty. Widening the range of software used may alleviate this problem.
3. Dealing with the small number of "passengers". There were students who took little part in producing materials and were content to ride on the back of others' initiative. There were no overt complaints from the other students. Those doing the carrying saw this as inadequacy on the part of the passengers.

Summary

These students have Physical Education as their main subject with little experience in a classroom setting. Initially most of the students felt that they would not be able to cope with the task, but at the completion of the module, many asked for more micro-teaching. Also, students took their three roles in this task very seriously. They diligently prepared their lessons, paid careful attention when being taught, and provided measured, thoughtful feedback. The task was scheduled just before their first school experience, and it provided a real boost to the confidence of the group. The immediacy of the peers'feedback also enhanced their confidence. The use of the college observation sheet focused their attention on issues such as use of voice, body language and delivery mechanisms.

"IT Big Days"

Background

Big Days started in 1988 in order to make use of IT and to provide a common experience for discussion and reflection on an educational issue for all students. Examples of issues discussed were:

1. Competition and cooperation in learning
2. Aspects of the new national curriculum
3. Contentious issues

The Big Days have evolved as the student numbers have grown and the time available has been reduced from 6 to 3 hours. Big Days now deliver some of the IT skills components of the B.Ed. Context Studies course rather than making use of IT as a vehicle for exploring educational issues. However, Big Days do allow IT students to become involved in peer group teaching at a very early stage in their degree course. The first Big Day during the course exemplifies the way in which students can increase both their IT competence and pedagogic development through peer group teaching of IT skills.

The CV and Word Processing Skills

The focus of the first big day is the Curriculum Vitae (CV). Every student has to produce a CV and a Letter of Introduction, which s/he will send to the placement school before the first teaching practice. This provides a task relevant to the student's needs and the incentive to learn the skills in order to complete the task.

Nature of Activity

All first year IT students are involved in the planning process for the Big Day which begins during the 8th week of their course. Only 90 minutes are available each week for tutor time. Many of the students will have had no previous knowledge of computers and most will not have used the word processor before starting the course.

Initially, the IT students must complete the activity themselves and then reflect on their own learning. The outcomes of these reflections are considered, and influence the preparation of materials/lesson plans for teaching a peer group of 12 students. This involves sharing strategies that might be employed in the 3 hour session, which they will lead. The teaching is carried out in computer rooms across the college on the "Big Day".

The teaching task carried out by the IT students ensures that all B.Ed. students are introduced to the college computer network, taught some basic word processing skills, given the experience of using a computer as a focus for small group work taught in a different environment, and are assigned the task of evaluating the learning experience.

Outcomes for IT Students

The Big Day is an opportunity for IT students to look at the differences between learning new skills themselves and teaching those same skill to others. The reflections on the day can be transferred to the classroom situation. By taking part in the planning and implementation of the Big Day, the students gain an awareness of the complexities of setting up a teaching situation. The bonus for all of the IT students is the excitement gained being seen in the role of the competent tutor by their peers and Context Studies tutors.

General Discussion Points

The nature of IT demands that we give students the ability to both develop and function independently. Once they are in school, they will have to work with little support and very tight budgets. The examples above illustrate the sort of activity which has proved popular and successful in placing the students on the road to independence, yet has been grounded firmly within a teaching and learning environment where they feel comfortable. From the college's point of view it is imperative that scarce resources are used efficiently and effectively.

The requirements of Circular 9/92 (DFE, 1992) hardly comprise a comprehensive strategy. We feel that within the institution we have to encourage all students to want to use IT where appropriate and give significant numbers of our students the knowledge and inclination to contribute positively yet critically to the use of IT in schools.

One of the most satisfying aspects of the IT provision made on the B.Ed. is the anecdotal evidence which suggests that IT competence has given students a distinct edge at interviews for jobs.

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Footnote

Copies of documents related to our courses are available on request from the authors.

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Information Technology in the Students' First Year of Teacher Education - Developing Classroom Experience

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Her Majesties Inspectors of Schools have recently commented on the inadequate coverage of IT for students in Initial Teacher Education as part of their recent report "New Teachers made little use of Information Technology in the lessons observed by HMI" (HMI, 1993). They also noted new teachers expressed dissatisfaction with their training in this area. This is not surprising, in view of the fact that a substantial proportion (over 40%) of undergraduates have not used a computer before arriving at college (Davis & Coles, 1992). At the University of Exeter, we have been trying to address this problem through a range of strategies including the provision of discrete IT courses, monitoring student progress in IT, and expecting the use of IT by students with children as part of school experience (teaching practice).

Monitoring Student Progress

The School of Education at Exeter offers initial teacher education places to students to become primary or secondary teachers, either as undergraduates or postgraduates. This report considers one cohort of the undergraduate primary course. In order to monitor the development of IT skills amongst these students, during their second year they complete a profile form to record their perceptions of their developing IT competencies. Part of this profile form consists of a feedback sheet which they return to us. This report summarizes their responses from the feedback sheets and comments upon their use of IT in schools. The cohort size was 120 and responses were received from 81 students (68% of the group).

The feedback sheet used consisted of 10 questions intended to elicit a range of factual information and students' perceptions about their own skills and attitudes. It was not piloted, but was a development from a profile sheet used the previous year. The questions were as follows:

Question 1 - Have you used some aspect of IT with children in the classroom? Yes/No
81 responded Yes (100%)

Question 2 - Do you feel confident that you can plan curriculum activities involving the use of IT? Yes/No
51 responded Yes (63%)

Question 3 - Can you use a word processor or a desk top publishing package to present your assignments? Yes/No
70 responded Yes (86%)

Question 4 - Please circle any of the following IT applications you feel confident about using in the classroom

Word Processing	Data Handling	Logo	Paintbox
84%	44%	70%	68%
Adventure Game	Floor Robot	Control Technology	
52%	42%	2.5%	

(These headings were chosen as they appeared to offer IT applications which students could easily identify)

Question 5 - Please circle any of the following IT applications you feel very unhappy about using in the classroom

Word Processing	Data Handling	Logo	Paintbox
7.5%	33%	15%	8.6%
Adventure Game	Floor Robot	Control Technology	
15%	31%	84%	

Question 6 - Which of the following computer systems do you feel confident about using?

Acorn A3000	RM Nimbus	BBC B/Master
68%	41%	46%
Opus/IBM Compatible	Apple Macintosh	
11%	12%	

Question 7 - Do you have your own computer to use for college work? Yes/No

25% responded Yes

Question 8 - If 'yes', what activities do you use it for? (The percentages refer to the group owning computers)

Word Processing	Desk Top Publishing	Music	Art
92%	20%	0%	40%
Spreadsheet	Data Handling	Communications	Games
50%	40%	0%	40%

Question 9 - What sort of computer system is it?

IBM Compatible	Amstrad WPC	A3000	Amiga
11	5	1	1
BBC B/Master	Other		
4	1 (Sharp word processor)		

Question 10 - What are your main priorities with regard to developing IT skills?

40% wanted more confidence in the use of IT, 16% more experience and 7% more knowledge of how to apply it in the classroom.

Question 11 - How can the college better help you to develop the skills you need?

43% wanted more workshops and lectures, 14% more notes and printed information, 10% wanted better access, 5% more advice and 4% wanted IT related assignments

Analysis

The fact that all the students who returned their feedback sheets had used IT in the classroom during 1991-1992 is a considerable achievement, and compares well to the sample of 52% who used IT on block teaching practice across 5 institutions in a pilot project which considered the development of IT in teacher education in England (known as Project Intent). In the past it has not been possible to insist on all students using IT in the classroom (despite the fact that this is required by the Council for Accreditation of Teacher Education, the government instituted body which approves teacher education courses in England). In their first year, all students undertake a self assessed school experience consisting of eight single days and a three week block in a local primary school. In order to ensure the use of IT, it was decided to incorporate a school based assignment involving the classroom use of IT. This assignment was in two parts; the first part required the students to observe and evaluate a group of children learning with IT in the classroom. This had to be presented as a short essay. The second part was to prepare and undertake a curriculum based activity involving the use of IT with a group of children. This work had to be presented as a display, thus giving the students the opportunity to develop their skills in display as well as using IT with children. There were a small number of the cohort (about 3) who were not able to use IT in the classroom because the computer had been stolen, and negotiated to submit an alternative assignment. None of this group returned their profile forms.

Comments from students in their assignments and the quality of work submitted have verified this to have been a positive experience in the majority of cases and enabled the students to overcome their inhibitions about using IT in the classroom. One major area of difficulty was the poor quality of IT usage by the teachers in their classroom (in many cases it was only used for copy typing final drafts of written work) and the lack of a positive model upon which to build. From evidence provided by 107 of the students in this cohort, documented by their assignments, it would seem that 20% of classes did not use the computer, 25% used it purely for copy typing of final drafts of written work, and 16% used it only for games. In other words, only 39% of the classes in the sample used IT for educationally significant activities.

This pattern has been reflected in subsequent years; in both 1992-1993 and 1993-1994. A number of students commented that they had difficulty with their assignments because of the schools lack of ability to address IT. In 1992-1993, from a cohort of 167, 14 were unable to use IT due to teacher resistance, illness, or machine breakdown. One student stated in her assignment that "When I told the class teacher that we were expected to complete an assignment on children using computers she stated quite simply that we would not be able to. She could not see any value in attempting to introduce her class to using computers and when I questioned the children I found that many had similar views." If this attitude is reflected nationally, then it raises significant issues about support and resourcing, particularly in view of the government's wish to substantially increase the proportion of the training of teachers undertaken by schools. The question remains, "how can we ensure all students receive positive models of the use of IT in schools?"

The fact that 63% are already confident about planning their curriculum work to include IT shows that this has now become a part of the teaching toolbox of a substantial majority of the group. The 37% who are still not confident give cause for concern, but it must be remembered that this survey was undertaken at the start of their second year of training; presumably there will be other curriculum activities which they are also unsure at this stage, and may well remain so until well into their teaching careers. In order to find out whether the positive attitudes to IT have been developed, it will be necessary to survey the students at the end of their second school experience, a ten week long assessed teaching practice. The fact that only 86% of the group can word process assignments is somewhat surprising, as this was a requirement of the entire cohort. Of this, a proportion could be due to students who missed part of their IT course due to sickness; an alternative is that the course concentrated primarily on educational applications and some specific tuition in personal use of IT is necessary. We also need to tighten up on assessment of students work by checking that they all submit word processed assignments where required. It is planned that in the future all assignments will be word processed. It may also be necessary to offer specific word processing/ keyboarding skills courses or flexible learning materials in future in order to address this problem. In conjunction with this, it must be noted that pressure of use on our IT facilities by students undertaking their own work has increased enormously to such an extent that certain resources are being used at full capacity. This has serious implications for future resourcing which is currently being addressed. With regard to their confidence in using educational applications of IT, the numbers shown paint a positive picture. The weakest area is Control Technology, which was not included as part of the basic course apart from a brief consideration of the use of floor robots (except for 24 primary science students who had an introduction to Control Technology). Of those who were not confident in specific applications, it would seem that further work is needed with data handling and floor robots. This reflects practice in local schools used for school experience, where control technology (other than the use of floor robots) does not appear to be used, or data handling, which seems to be attacked in a somewhat superficial manner. Further development work is needed in this area. The university has offered inservice courses for local teachers on Control Technology.

It would appear that most students are confident with at least one of the computer systems on campus, many are confident with two. This indicates that they have learned to transfer knowledge from one system to another. Anecdotal comments from students suggest that they do not see transfer between systems as being a major problem, providing there is a support system to help them cope with the initial stages and subsequent technical problems. The School of Education has a team of three IT technicians, of which at least one is available most of the time to support students, and other subject areas have their own technicians who are trained to provide similar support. The provision of suitably trained and experienced technicians would appear to be essential to the effective introduction of IT. At the time of this survey (November 1992), one in four of this group had their own computer for use with college work. This was a surprisingly high proportion, and comments from students would indicate that it is likely to increase. Indeed, by November 1994 the proportion has increased to 47% of the first year cohort. These appear to be mainly used for word processing assignments, but some also use them for other personal purposes as well as games. The majority of these systems were IBM compatible computers, with a number of dedicated word processors and BBC computers. This move towards students having their own systems must be welcomed as it relieves pressure on the college resources. There are, however, implications for support - to what extent can our technicians be expected to assist students with problems they are having doing college work on their own systems? A clear policy is needed with regard to supporting students in this area. Another problem is that the minimum specification of computers is rapidly increasing in order to use environments such as Windows and to handle high quality graphics and sound - this means that the unit cost of a computer system is actually increasing whilst the students' grant is decreasing. The government has chosen to reduce the student grant by 10% a year over three years and replace it by a loan. This is taking place in a context where there is little casual work or vacation work available for students. This seems to be leading to a situation where students will begin their teaching careers with a large burden of personal debt. With regard to developing their own IT skills, the factors most needed are self confidence and experience, (which should develop with classroom experience and increased use of IT) but it must be noted that a substantial proportion requested more IT specific teaching time (our IT courses consist of a mixture of lectures, workshops and seminars in groups of up to 16 students). We also need to provide a better resource of notes and information to back up what they have learned.

Conclusions

This survey seems to present a positive viewpoint of what our primary undergraduate students have achieved regarding the use of IT at the end of their first year with regard to the educational use of IT, and contrasts well with the lack of confidence expressed in a survey on entry (Blackmore, M., Coles, D., Hodgkinson, K., Stanley, N., Taylor, C., & Vaughan, G., 1992). There is still much to be done, especially with regard to data handling, curriculum planning involving IT, and ensuring better use of IT for personal work. Some future course development will be needed to ensure areas of uncertainty such as Control Technology are covered effectively. Measures have been taken to ensure that individuals cannot slip through the net by missing sessions such as word processing. Despite curriculum reviews and slimming down processes, the core work in IT in our schools still emphasizes data handling and control as being essential areas. The university also needs to introduce an effective backup support for students seen to be failing. The course review and mapping exercises have been undertaken, to better aid the situation, by identifying areas of weakness further on in the primary course.

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From College Instructor to Second Grade Computer Teacher: I Learned My Lesson

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I believed my ten years of teaching at the University of Wyoming prepared me to teach anywhere. I taught pre-kindergarten through ninth grade in the College of Education's laboratory school, developed and taught college-level technology courses, and supervised practicum students. My philosophical base was firm; my ideas expressed with confidence. Then I moved and accepted the position of "Computer Teacher" in a public elementary school.

My first visit to the school for my interview was the beginning of an awakening for me. The lab had Apple IIe computers. So did the classrooms, though new computers had been ordered. The position itself was incongruent with my philosophy of technology integration, yet I was intrigued by the challenge of putting my theories into practice in a new setting. Now that I have been teaching in this public school for almost a semester, I see how some of my expectations for preservice teachers were unrealistic and idealistic. I have learned my lesson! I would like to share what I have learned in three areas: total mistakes, important things I left out, and finally, what I did right in my technology courses for preservice teachers.

Total Mistakes

This is depressing, but I should begin with my most serious blunders. My first concerned the *dinosaur called Apple IIe. One won't find many of these around, so many do not spend any time learning how to use it.* Yet there are many Apple IIe's and IIGS'es still in use, especially in elementary schools. As they are phased out, districts are reluctant to spend money on new software for this format. So not only might a new teacher be expected to use an old computer, he or she could also have the added burden of primitive software.

My second total mistake was this one: *Since computer programming is no longer a required subject, it is not a skill that is commonly needed.* While I believe that programming is not an essential computer skill, per se, programming can be a fun and real turn-on to bright kids who are forced to use clunky computers. *Logo* is the one piece of software many schools with Apple II's have. It might be in the back of the closet and covered with dust, but it is still a wonderful tool. Problem solving and critical thinking skills are emphasized in every curriculum guide I have seen in the last five years, and programming is an excellent vehicle for reaching these outcomes. And even though I did not recognize it at the time, when I required my college students to put together *HyperCard, LinkWay*, or *HyperStudio* presentations, they were actually programming.

My next piece of advice to my college students is embarrassing in its arrogance: *Do not avoid teaching in a school where technology integration is not a high priority or not supported by the teachers and/or administrators.* As I have found out, many factors figure in to a teacher accepting a position. While it might be ideal to a find a school with excellent technology tools and teachers who know how to use them, there might not be an opening there. Another good reason to accept a position at a struggling school is to join the struggle and even direct it in positive ways. A new teacher, well-grounded in appropriate technology integration, can have a powerful impact on a faculty and administration. New teachers can quickly become technology leaders and agents of change in their schools.

Finally, I fell prey to futurist hype on this one: *We don't need to teach keyboarding because speech input is close at hand.* Well, maybe speech input is close and maybe it isn't. It certainly will be a long time in coming to our schools. In the meantime, teaching young children "home position" will help them right now, as they work on their writing. I still do not believe in heavy emphasis on keyboarding, but children like to type "like grownups" and they quickly see its usefulness. I teach children home position and have them practice it on a word processor. This doesn't take a lot of time, and it forms a useful habit that these children might need for a number of years to come.

Things I Left Out

There is never enough time in a semester to cover everything, but I know now that I left out some critical skills in my technology courses. Very often, to save time, I would unjam the printers, trouble-shoot the equipment, and swap out cards to get things going again. Now I know that those are the very skills that many teachers lack but which are desperately needed in smoothly functioning classrooms. Many schools have computer labs that stand empty simply because the classroom teacher is not confident enough to function there. If I had it to do over again, *I would be slower to rescue my college students and give them more time to figure out solutions themselves.* I would not spend a lot of time teaching the "innards," but I would have them take an Apple II completely apart, including cards, just to give them the confidence that they could do it if they had to. And I would make them assemble it again using a manual, which may be their only source of help later on the job.

Another important skill I would include for preservice teachers is *how to plan and deliver an inservice to their colleagues or a presentation to their school board.* A requirement of this assignment would be to use presentation software in a presentation to peers, just to allow for practice with a skill that might be called on to use. In my short time on the job, I have already taught two inservice workshops. Being able to "present their case" to a school board to garner support for technology purchases is a skill many of my former students have told me they developed on the job. Having practice ahead of time, in class, would have been helpful.

The last skill I almost completely omitted in my courses was *adapting computer use for special needs children.* When I started teaching in a public school, I was unprepared for the number of special needs children I would have, as well as for the sheer diversity of their needs. Technology can be wonderfully adaptive, but many of the adaptive devices are not in the public schools. I wish I had asked my college students, "How would you teach word processing to a child with no arms?" If I had, I would have a solution for one of my students. I also have a deaf student, a partially blind students, an autistic student, and emotionally disturbed students. I am committed to meet the needs of individual students, but since I teach over 550 children each week, it's a real stretch to even learn their names. Classroom teachers don't have to deal with the number of students I do, but they do have students who will tax their creativity. I wish I had prepared my college students for this particular challenge.

One assignment that I gave my college students was to teach an actual technology-based lesson to real students the age they hoped to teach. This was an easy task to facilitate with the laboratory school in such close proximity, and it proved to be the assignment my college students valued the most. They could use the lab school's excellent technology resources and were able to develop and deliver powerful lessons. But if I had it to over again, I would also require them to teach a lesson with less than optimal technology resources, more closely replicating what they are likely to find in the "real world." Through this experience, they would have learned how to be creative and flexible, two attributes teachers need daily. They also would have discovered on their own, rather than have me tell them, that two students working together on a computer is often better than one student working alone.

What I Did Right

Happily, in many ways, my college students were well-prepared by my practical assignments. I love it when they return and share experiences about what they have been able to really use in their teaching. Now I have my own experience to know what is useful as well.

One assignment I gave was to prepare a list of software that they would buy if their principal suddenly had $500.00 to spend before the school "lost" it in 24 hours. I asked them to provide justification for each purchase as well. In my new job, I was asked to propose software and hardware for our school's Chapter II monies, only I had 48 hours to do it. *I advised students to always have a "wish list" at hand,* and I know many have used it. This assignment is also a good foundation for grant-writing, an important skill for a teacher who wants to have a well-equipped classroom.

One small but important unit I included in my technology class was *how to write instructional objectives.* No one else seemed to be teaching this skill, and I wanted my students' assignments to have clear objectives. Now I know first-hand how useful this skill can be. As a new teacher in my district, I was required to turn in my first two months of lesson plans, complete with objectives, to the principal. I am sure many of my former college students are facing a similar requirement and are glad they were prepared for it.

I also feel that class time spent *discussing educational philosophy* was vital. When I went for my job interview I could clearly state why I was against having computer classes separate from the "regular" classroom. Arguing against having the "computer teacher" position proved to be an effective way to get the position. My principal understood my point of view and asked me to be patient. She knows our faculty, and I trust her understanding of the best way to move them toward computer integration. When my former college students are asked to teach in a way that is incongruent with their philosophy, at least they will be able to articulate why it is incongruent. And with that knowledge, I feel they are prepared to help schools move forward.

My preservice students teamed on many assignments, giving them a skill that is widely used in my school. I am glad that I required them to learn first-hand about cooperating with someone to get a job done. The teachers in my school who team are the ones who are excited about teaching. They are the risk-takers, the ones who try new ideas to find out if they work. They have learned first-hand how wonderful it is to have someone with whom they can brainstorm, and with whom they can solve problems. These are the teachers who network and share resources and good ideas with others in the school and the district. This attitude of sharing is one that I fostered in my classes, and it is the quality I now admire most in my colleagues. I am happy that I encouraged cooperation and teamwork in my classes because I have seen how well it works among the teachers in my school.

My Lesson

My philosophy for preservice teaching assignments is this: the more practical and "real world" the better. I thought I was immersed in the "real world" when I taught in a university lab school. I found out that I was vulnerable to ivory tower isolation. I am sorry that my college students who were prepared to teach children and adolescents how to build wonderful multi-media projects may only have a dusty Apple II in their classroom. I am disappointed that my college students who learned how to develop technology-based thematic units may only have access to an IBM lab with drill and practice software. Yet I am pleased that my college students have the vision and expertise to use better technology tools and to use them appropriately. My hope is that they will become advocates for procuring better tools for their students, that they will share their technological skills and philosophical convictions with their colleagues, and that they will team with other teachers to solve difficult problems. The lesson I learned is that I needed current public school experience myself to prepare teachers to teach there.

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Technology Instruction for Preservice Teachers: An Examination of Exemplary Programs

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Ever since the advent of technologies into society and the work place, teacher education programs have struggled with the question of how to teach and apply the wide variety of technologies that are available to enhance the teaching and learning process (Wetzel, 1992). The introduction of film in the early 1900s, educational radio in the 1920's, instructional television in the 1950's, and computer-based technologies in the late 1970's have all been plagued by teachers' lack of knowledge as to how to use them in instruction and colleges' of education lack of adequate preparation of preservice teachers (Cuban, 1986). A review of the literature supports the position that the biggest obstacle to the use of technology in education is the lack of adequate teacher training (Dupagne & Krendl, 1992; Drazdowski, 1990; Beaver, 1990; Brooks & Kopp, 1990). Moursund (1989) is even more emphatic in his criticism: "...by and large, our colleges of education are doing a miserable job of preparing teachers to deal with the Information Age" (p. 9). Many educators have offered suggestions regarding proposed objectives and instructional strategies for preservice teacher education in technology. These range from self-paced, self-taught modules to lecture-type technology demonstrations. The premise is that technology will be fully integrated into the coursework, both on the part of the instructor presenting the information and in the tasks and projects required of the preservice teachers (Brent, 1992; Neiss, 1991; White, 1991; Beaver, 1990). The expected outcome of these courses is for the preservice teachers to gain a certain level of computer literacy; the exact level and specific competencies to be attained is dependent on the particular institution. White (1991) suggests that preservice teachers must have an understanding of concepts regarding what computers can do, what learners can do with computers, and what teachers can do with learners and computers. Neiss (1990) asserts that preservice teachers must have a general education about computers early in their college preparation, not in their final year of the teacher preparation program. In addition, in order for the preservice teachers to feel comfortable integrating technology into the curriculum they must first feel comfortable with technology as a tool for personal productivity.

Purpose of the Study

The purpose of this study was to examine teacher education programs that were perceived as exemplary in providing instruction in technology for preservice teachers in order to develop a descriptive model of their collective instructional and curricular practices. Several questions guided this study. In examining the introductory technology course the questions asked were: Is an introductory course in technology required for preservice teachers? If so, at what point in the teacher education program is this introductory technologies course taken? What instructional delivery methodologies are employed in the introductory technologies course? For what hardware and software technologies is instruction provided in the introductory technologies course? How are preservice teachers required to demonstrate competence in or mastery of these technologies?

Similar questions were asked of the advanced technologies course for preservice teachers. Is an advanced course in technology required for preservice teachers? What instructional delivery methodologies are employed in the advanced technologies course? For what hardware and software technologies is instruction provided in the advanced technologies course? How are preservice teachers required to demonstrate competence in or mastery of these technologies?

Methods

A "nominating committee" was selected for the purpose of identifying teacher education programs considered exemplary in providing instruction in technology for preservice teachers. The nominating group consisted of 184 individuals who were members of one or more of the following: (1) presenters at the 1993 annual conferences of Society for Technology and Teacher Education (STATE), Association for Education and Communications Technology (AECT), or National Educational Computing Conference (NECC) whose presentation dealt with technology and teacher education and whose presentations were included in the conference proceeding of the conference; (2) members of the editorial review boards of Journal of Educational Multimedia and Hypermedia, Journal of Computing and Childhood Education, Journal of Computers in Math and Science, Journal of Technology and Teacher Education, Tech Trends; (3) members of 1993 boards of directors of the Association for Educational Communications and Technology (AECT), International Society for Technology in Education (ISTE), or American Association of Colleges for Teacher Education (AACTE). Each member of the nominating committee was asked to identify three institutions, other than their own, which they believed to be exemplary in providing instruction in technology for preservice teachers. Further, an institution had to be nominated by at least two individuals to be included in this sample of exemplary institutions. An equal number of institutions was randomly selected from all colleges having teacher education programs which were members of the American Association of Colleges for Teacher Education. Deans, chairs, or coordinators of the teacher education programs of all institutions included in the study were contacted to secure their consent to participate in the study and to obtain the names of the instructors of technology courses and teaching methods courses.

Survey questionnaires were sent to each of the instructors in the institutions, the responses were tabulated, and institutional profiles were constructed for each institution. Since the data types of the questionnaire items were nominal, frequencies and percentage of total responses were tabulated on each item. Chi-square tests of independence (alpha <= .05) were employed for each of the items to determine whether the differences between the exemplary and comparison groups were indeed statistically significant. Internal reliability of the instrument (.919) was established using the Cronbach Coefficient Alpha.

Results

Introductory Technology Courses

Of the 36 comparison institutions 24 responded. Table 1 reports the results of the question concerning the requirement of a basic skills, introductory course in technology for preservice teachers. The findings indicate that a high percentage (greater than 91%) of both exemplary and comparison institutions require an introductory course in technology for some or all preservice teachers.

Table 1
Is an introductory, basic skills technology course required of pre-service teachers?

	Exemplary	group%	%Chi	p
	Comparison		square	
required of all	79.4	70.8	.886	.642
required of some	11.8	20.8		
not required	8.8	8.3		

Note: *df* = 2; Significance <=.05 indicated by *, n = 34 n = 24

Table 2 reveals the responses to the question that addresses at that point in the preservice teacher education program this introductory technology course is to be taken. A high response rate was recorded for those requiring the course be taken during the third (53.9%) or fourth (32.4%) years. The response totals exceeds 100% because some institutions offer more than one introductory technology courses with varying recommendations for taking the courses.

Table 2
At what point in the preservice teacher education program is it recommended the basic skills technology course be taken?

	Exemplary Group	Comparison group	% Chi square	p
first year	26.5	25.0	.016	.899
second year	29.4	20.8	.539	.462
third year	52.9	37.5	1.348	.246
fourth year	32.4	33.3	.006	.938
fifth year	11.8	0.0	3.033	.082
no recommendation	41.2	45.8	.124	.724

Note: *df* = 1 in all cases; Significance <=.05 indicated by *, n = 34 n = 24

A variety of instructional delivery methodologies are employed by both exemplary and comparison institutions as shown in Table 3. All of the institutions in this study provide hands-on technology laboratories for the preservice teachers. They also use demonstrations and lectures to a great extent in the presentation of and instruction in the various technologies. The comparison institutions also make more substantial use of self-instruction modules in the delivery of instruction than do the exemplary institutions.

Table 3
What instructional delivery methodologies are employed in the basic skills technology course?

	Exemplary Group%	Comparison Group %	Chi square	p
hands-on technology lab	100.0	100.0		
demonstration: no hands-on	79.4	62.5	2.014	.156
lecture	76.5	79.2	.059	.808
self-instruction modules	38.2	62.5	3.317	.069
workshops	17.6	16.7	.009	.922
other	2.9	16.7	3.365	.067

Note: $df = 1$ in all cases; Significance <=.05 indicated by *, n = 34 n = 24

Table 4 shows the wide variety of hardware technologies that are included in the basic skills, introductory technology course. For only two of the hardware technologies, integration of multiple technologies and the use of image/page scanners, is there statistically significant differences. There is also evidence that the exemplary institutions include more of the advanced technologies than do the comparison institutions. Some points of interest are the high level of inclusion of the VCR and the related inclusion of video/video editing by the comparison institutions.

Table 4
What hardware technologies are included in the introductory, basic skills technology course?

	Exemplary Group %	Comparison Group %	Chi square	p
computer	100.0	100.0		
CD-ROM	91.2	75.0	2.808	.094
interactive video disc	76.5	58.3	2.162	.141
e-mail/telecommunications	70.6	58.3	.935	.334
integration of multiple technologies	58.8	29.2	4.973	.026*
VCR	55.9	79.2	3.365	.067
image/page scanner	55.9	25.0	5.471	.019*
digitized images	32.4	25.0	.367	.545
video/video editing	23.5	33.3	.677	.411
distance learning systems	11.8	25.0	1.727	.189
MIDI	5.9	4.2	.084	.771
other	2.9	16.7	3.365	.067

Note: $df = 1$ in all cases; Significance <=.05 indicated by *, n = 34 n = 24

The wide variety of software technologies included in the introductory, basic skills technology course is identified in Table 5. Instruction in many of the traditional software technologies is provided by both exemplary and comparison institutions (word processing, database, drawing/graphics, tutorials, games, simulations, drill and practice, spreadsheet, gradebook). Statistical significance between exemplary and comparison institutions was found in the use of drawing/graphics, image/page scanning, and digitizing images. Of particular interest is the slightly higher use of LOGO/LOGOWRITER by the comparison institutions and the inverse significance in the inclusion of BASIC/QBASIC by the comparison institutions.

Table 5
What software technologies are included in the introductory, basic skills technology course?

	Exemplary Group %	Comparison Group %	Chi square	p
word processing	91.2	100.0	2.233	.135
database	85.3	83.3	.041	.839
drawing/graphics	85.3	58.3	5.334	.021*
tutorials, games, simulations, drill	82.4	83.3	.009	.922
spreadsheet	79.4	79.2	.001	.982
Hypercard/Linkway	70.6	58.3	.935	.334
gradebook	67.6	70.8	.067	.796
image/page scanning	61.8	20.8	9.530	.002*
desktop publishing	41.2	54.2	.954	.329
digitizing images	41.2	4.2	10.051	.002*
operating systems	32.4	33.3	.006	.938
presentation software	32.4	16.7	1.806	.179
LOGO/LOGOWRITER	20.6	33.3	1.192	.275
BASIC/QBASIC	2.9	25.0	6.451	.011*
other software	11.8	8.3	.179	.673
other high level authoring tools	5.9	0.0	1.462	.227
C+/C++/Pascal	0.0	0.0		

Note: $df = 1$ in all cases; Significance <=.05 indicated by *, n=34, n=24

As can be seen in Table 6 the preferred method of assessing competence in or mastery of the hardware technologies in both exemplary and comparison institutions is to require students to develop and complete projects. Student presentations and written tests are also used in the exemplary institutions in assessing competence in hardware technologies for preservice teachers.

The final question in examining the introductory, basic skills technology course for preservice teachers examined how the preservice teachers demonstrated competence in or mastery of the software technologies included in the course. As can be seen in Table 7, the methodologies employed to assess competence in software technologies is very similar to those in assessing competence in the hardware technologies: use of student projects, student presentations, and written tests.

Table 6
What methods are used to assess competence in or mastery of the hardware technologies included in the introductory, basic skills technology course?

	Exemplary Group %	Comparison Group %	Chi square	p
completed projects	97.1	87.5	2.002	.157
student presentations	61.8	58.3	.069	.792
written tests	50.0	54.2	.098	.754
competency checklists	29.4	37.5	.418	.518
other	5.9	12.5	.782	.376

Note: *df* = 1 in all cases; Significance <=.05 indicated by *, n=34 n=24

Table 7
What methods are used to assess competence in or mastery of the software technologies included in the introductory, basic skills technology course?

	Exemplary Group %	Comparison Group %	Chi square	p
completed projects	88.2	87.5	.007	.933
student presentations	64.7	45.8	2.043	.153
written tests	41.2	50.0	.443	.506
competency checklists	29.4	37.5	.418	.518
other	8.8	8.3	.004	.948

Note: *df* = 1 in all cases; Significance <=.05 indicated by *, n=34 n=24

Advanced Technology Courses

Of the 36 exemplary institutions included in the survey 19 responded to the advanced technologies section and of the 36 comparison institutions 7 responded. Table 8 reports the results of the question concerning the requirement of an advanced technologies course in technology for preservice teachers. As can be seen in Table 8, advanced technology courses are offered and required to a varying degree. For exemplary institutions, 68.4% do not require advanced technology courses of their preservice teachers. Because responding to the survey questionnaire was voluntary, it is not possible to ascertain that the institutions that did not respond do not offer advanced technology courses.

The instructional delivery methodologies employed in the advanced technologies courses are identified in Table 9. In comparing the instructional delivery methodologies of the advanced technologies courses with the introductory technologies course it is to be noted that the advanced technologies courses have reduced the level of hands-on instructional methodologies and increased those methodologies that rely on lecture and demonstration.

Table 8
Is an advanced technology course required for pre-service teachers?

	Exemplary Group %	Comparison Group %	Chi square	p
required of all	0.0	14.3	3.445	.179
required of some	31.6	42.9		
not required	68.4	42.9		

Note: *df* = 2; Significance <=.05 indicated by *, n=19 n=7

Table 9
What instructional delivery methodologies are employed in the advanced technologies course?

	Exemplary Group %	Comparison Group %	Chi square	p
hands-on technology lab	94.7	85.7	.586	.444
demonstration: no hands-on	84.2	100.0	1.249	.264
lecture	78.9	100.0	1.742	.187
self-instruction modules	42.1	71.4	1.759	.185
workshops	26.3	42.9	.657	.418
other	10.5	14.3	.071	.790

Note: *df* = 1 in all cases; Significance <=.05 indicated by *, n=34 n=24

There is value in examining the hardware technologies in the introductory basic skills course (Table 4) along with those included in the advanced technologies course (Table 10). Progressions of technology instruction become more evident in this cross-referenced examination. The inclusion of the computer (89.5%) and CD-ROM (89.5%) has decreased. The more advanced technologies such as digitized images (73.7%), integration of multiple technologies (68.4%), image/page scanner (68.4%), video/video editing (63.2%), and the MIDI (36.8%) have all increased substantially. In addition, when observing the high levels of inclusion of all the hardware technologies in the exemplary institutions, it is evident that the exemplary institutions offer a broad range of hardware technologies for the preservice teachers.

As with the hardware technologies, the software technologies included in the advanced technologies course (Table 11) provide indications of the progression of instruction when examined in conjunction with those of the introductory technologies course (Table 5). The inclusion of productivity software technologies (word processing, spreadsheet, and gradebook) is decreased in the advanced course. At the top of the list is the instructional software (tutorials, games, simulations, drill and practice) at 78.9%, drawing/graphics (73.7%), Hypercard or Linkway (73.7%), image/page scanning (68.4%), presentation software

(63.2%) other high level authoring tools (57.9%), and digitizing images (57.9%). These are software tools used in the creation of the more advanced lessons, instruction and coursework by preservice teachers. The increase in levels of inclusion of operating systems, the programming languages BASIC/QBASIC and C+/C++/Pascal indicate that the advanced course has taken on some of the more complex technological issues.

Table 10
What hardware technologies are included in the advanced technologies course?

	Exemplary Group %	Comparison Group %	Chi square	p
computer	89.5	100.0	.798	.372
CD-ROM	89.5	57.1	3.442	.064
interactive video disc	78.9	71.4	.163	.686
digitized images	73.7	42.9	2.148	.143
e-mail/telecommunications	68.4	57.1	.287	.592
integration of multiple technologies	68.4	57.1	.287	.592
image/page scanner	68.4	42.9	1.412	.235
VCR	63.2	57.1	.078	.779
video/video editing	63.2	42.9	.864	.353
MIDI	36.8	14.3	1.222	.269
distance learning systems	31.6	42.9	.287	.592
other	26.3	0.0	2.281	.131

Note: *df* = 1 in all cases; Significance <=.05 indicated by *, n=34 n=24

Table 11
What software technologies are included in the advanced technologies course?

	Exemplary Group %	Comparison Group %	Chi square	p
tutorials, games, simulations, drill	78.9	42.9	3.128	.077
drawing/graphics	73.7	42.9	2.148	.143
Hypercard/Linkway	73.7	42.9	2.148	.143
image/page scanning	68.4	42.9	1.412	.235
word processing	63.2	42.9	.864	.353
presentation software	63.2	28.6	2.462	.117
other high level authoring tools	57.9	57.1	.001	.973
digitizing images	57.9	28.6	1.759	.185
spreadsheet	47.4	57.1	.195	.658
operating systems	47.4	57.1	.195	.658
desktop publishing	42.1	42.9	.001	.973
database	42.1	28.6	.396	.529
gradebook	26.3	57.1	2.148	.143
BASIC/QBASIC	26.3	14.3	.417	.518
other software	15.8	0.0	1.249	.264
LOGO/LOGOWRITER	10.5	14.3	.071	.790
C+/C++/Pascal	10.5	0.0	.798	.372

Note: *df* = 1 in all cases; Significance <=.05 indicated by *, n=34 n=24

The assessment methodologies for the advanced technologies course (Table 12) follow closely those of the introductory technology course (Table 6). They show a preference for projects, presentations, and written tests as means of assessing mastery of or competence in the hardware technologies.

Table 12
What methods are used to assess competence in or mastery of the hardware technologies included in the advanced technologies course?

	Exemplary Group %	Comparison Group %	Chi square	p
completed projects	94.7	85.7	.586	.444
student presentations	84.2	85.7	.009	.925
written tests	68.4	71.4	.022	.883
competency checklists	31.6	28.6	.022	.883
other	10.5	0.0	.798	.372

Note: *df* = 1 in all cases; Significance <=.05 indicated by *, n=34 n=24

As with the hardware technologies, the preferred methods of assessment for software technologies (Table 13) is also projects, presentations, and written tests. Note the substantial increase in the use of presentations and written tests on the part of the comparison institutions.

Table 13
What methods are used to assess competence in or mastery of the software technologies included in the advanced technologies course?

	Exemplary Group %	Comparison Group %	Chi square	p
completed projects 94.7	85.7	.586	.444	
student presentations	68.4	85.7	.778	.378
written tests 52.6	71.4	.740	.389	
competency checklists	31.6	28.6	.022	.883
other 10.5 0.0	.798	.372		

Note: *df* = 1 in all cases; Significance <=.05 indicated by *, n=19 n=7

Discussion

Introductory Technologies Course

This study revealed that 91.2% of the exemplary institutions require an introductory, basic skills technology course of some or all of its preservice teachers. These institutions also recommend this course be taken during the third (52.9%) or fourth year (32.4%) year of the teacher education program. The recommendation that this course be taken the third or fourth year may shed some light on the purported lack of inclusion of technologies in the teaching methods courses in the teacher education programs of many institutions. Many teacher education programs offer teaching methods courses beginning in the second year of their programs. If the preservice teachers have not yet had instruction or training in the operation and use of instructional technologies this task is left to the instructors of the teaching methods courses; this in addition to teaching the course content and pedagogy associated with those content areas.

In a related study (Vagle, 1994), several reasons were given be teaching methods instructors for not including the use of technology in their courses. One of the reasons was that although preservice teachers were required to take technology courses, these courses were not required until late in the teacher education program. As a result, the teaching methods instructors had the task of teaching not only the application of the technology to their content area but also the basic skills and operation of those technologies. The instructors of the teaching methods courses did not feel they had the knowledge, skill or the time to do this. If the use and application of educational technologies are to become an integral part of teacher education programs, instruction and training in these basic technologies must be included earlier in the education process.

The preferred instructional delivery methodologies for the introductory technology courses in the exemplary institutions are hands-on technology labs (100%), demonstrations with no hands-on experiences for students (79.4%), and lectures (76.5%). This is not surprising in that much of the learning of and about technology is skill-based and not unlike learning to play a piano. First the instructor must show the students how to do it, discuss with them concepts, techniques, and theories, then practice, practice, practice.

Hardware technologies incorporated into the introductory technologies courses fall into three distinct groups. In the first group, the computer (100%) and CD-ROM (91.2%) provide evidence of very high inclusion of these technologies into the preservice teacher education programs. The second group, interactive video disc (76.5%), and e-mail and telecommunications (70.6%) no doubt reflect the increase in the amount of videodisc materials being made available by instructional resource companies for use in the K-12 schools and the increase in the number of K-12 schools who are gaining access to the Internet for their teachers and students. As the application of these technologies are developed by elementary and secondary educators, the impetus for including these technologies in preservice teacher education programs increases. The third group of hardware technologies includes the integration of multiple technologies (58.8%), the use of the VCR (55.9%), and the image/page scanner (55.9%). It could be suggested that the use of the image/page scanner and the integration of multiple technologies might provide evidence that the introductory technology courses are attempting to provide instruction in the development of interactive learning modules for students such as might be developed through the use of Hypercard and Linkway. The data did not provide any indication as to the role the VCR plays in this instruction, particularly in light of the relatively low of inclusion of digitizing images. The high level of inclusion of the VCR by the comparison institutions might suggest that the VCR is still being used to capture film sequences for replay on a video tape player and not as an input source in the integration of multiple technologies into a learning module.

Software included in the introductory technologies course at exemplary institutions consisted primarily of personal productivity software (i.e., word processing, spreadsheet, database, drawing/graphics, gradebook) and instructional software (tutorials, games, simulations, and drill and practice). This is consistent with the findings of a study conducted for the International society of Technology and teacher Education [ISTE] (Lintner, Moore, Friske, Mlynarczyk, Thomas, & Wiebe, 1991). The exemplary institutions also included instruction in Hypercard or Linkway by virtually no instruction in BASIC. The comparison institutions indicated less use of Hypercard and Linkway but a greater inclusion of BASIC or QBASIC. Higher level programming languages such as C+, C++, and Pascal are not included by either the exemplary or comparison institutions. Researchers in the study for ISTE (Lintner et al., 1991) found that in the typical computer literacy course for education majors 87% of the courses included programming instruction with LOGO (65%) and BASIC (45%) being included the most frequently.

The differences in the findings of this study, as contrasted with the study conducted for ISTE (Lintner et al., 1991) with reference to the high level of instruction in Hypercard and Linkway and the lower levels of instruction in programming languages, could well be a reflection of a move away from programming languages, and toward the use of authoring tools. As newer, more powerful, easier to use authoring tools have emerged they have incorporated the ability to access a wide variety of peripheral devices that can provide for multi-sensory learning experiences. As this software technology has developed, exemplary institutions have begun to reduce the requirement for programming languages and have begun to include the more flexible, versatile, and powerful authoring tools.

The preferred methods of assessment in introductory technologies courses is congruent with many performance assessment models. These assessment models require the students to demonstrate knowledge and mastery of the skills through the use of projects and presentations that require the application of the skills. The preservice teachers are also given written tests that assess understanding of the theories, concepts, and applications of the technologies in the teaching/learning process.

Advanced Technologies Course

Of the 36 exemplary institutions included in and responding to the total study, only 19 responded to the section addressing advanced technologies courses. Because the responses were voluntary, it is not possible to ascertain that the institutions that did not respond do not offer advanced technologies courses. Of those responding, it is of interest that there was a greater incidence of an advanced technologies course requirement by the comparison institutions than there was of the exemplary institutions. However, the exemplary institutions reflected the inclusion of a wider variety of the more advanced technologies.

The higher frequency of inclusion of a wider range of hardware technologies would suggest that the advanced technologies course provides a focus on the application and use of a great number of technologies and less emphasis on the basic operational skills. Ideally, this course would provide an opportunity for the preservice teachers to refine their skills and develop proficiency in the basic technologies learned in the introductory technologies course. The software technologies included in the advanced technologies course reflected many of those in the introductory course with a reduced emphasis on some the personal productivity software (spreadsheet, database, gradebook). There is also evidence of greater emphasis on the software technologies that are involved in the application of technology to instruction such as substantial inclusion of tutorials, games, simulations, drill and practice. Also indicated, was the increased use of those software technologies that are used in the development of student created learning activities: Hypercard or Linkway, drawing/graphics, image/page scanning, digitizing images, and other high level authoring tools. The increased inclusion of operating systems, BASIC/QBASIC, LOGO/LOGOWRITER, and C+/C++/ Pascal also give indication that the advanced technologies course is addressing some of the more complex issues underlying the technological base.

As with the introductory technologies courses, the preferred instructional delivery methodologies are hands-on technology labs, demonstrations with no hands-on experiences, and lecture. The preferred means of assessing competence or mastery is similarly through the use of student projects, student presentations, and written tests.

Summary

The data would seem to indicate that through the use of introductory and advanced technologies courses teacher education programs are positioned to provide the opportunity for the preservice teachers to develop skills in a variety of technologies as well as basic instruction in how they are to be used in the instructional process. The data is not clear on whether or not the preservice teachers have developed an understanding of what Bitter and Yohe (1989) describe as the "processes" of technology, the ability to go beyond the application of the "products" of technology to the theoretical implications, to be able to generalize the use and application of a wide variety of technologies in the teaching and learning process even though they have not had specific training on them. Of equally great concern is to what extent are the preservice teachers provided instruction and opportunity to apply the knowledge gained in the technology courses within the various content areas? Are the teaching methods courses building on the skills and instruction developed in the technology courses through modeling, demonstrations, and opportunities for the development of deeper, more thorough instructional applications within the teaching methods courses? It appears that the technological foundation has been laid down as such that the pedagogical application structure can be built. The use of instructional technology as a tool for enhancing the teaching/learning process will never accomplish that of which it is capable until the integration of technology into the teaching methods courses becomes a part of the instruction and development of the preservice teachers.

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Technology in Teaching Methods Courses: Is it Happening?

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Instruction in educational technology is mandated by accreditation standards at both national and state levels. The International Society for Technology in Education [ISTE] has developed guidelines for educational computing and technology (ISTE Accreditation Committee, 1992; ISTE, 1992) that have recently been approved by the National Committee for Accreditation of Teacher Education [NCATE] (Thomas, Taylor, & Knezek, 1993; NCATE, 1992). NCATE has also incorporated guidelines developed by The Association for Educational Communications and Technology that address the inclusion of instruction in technology for teacher education programs (Caffarella, Earle, Hancloskey, & Richey, 1994).

Critics contend that the current methods of instruction in educational technology promote too narrow a technical focus and fail to provide the pre-service teachers with the knowledge necessary to fully integrate technology into the curriculum; few pre-service teachers have had any instruction in actually using technology in the classroom (Emihovich, 1992; Wood & Smellie, 1990; Gayeski, 1989). Colleges of education are not succeeding with attempts to integrate technology into the teaching process (Beaver, 1990; Turner, 1989).

The traditional educational technology course presented to pre-service teachers is usually a "show and tell" of technological capabilities which may spark interest but provides no depth or insight into use in the classroom (Callister & Burbules, 1990). A great deal of confusion results when a wide range of technologies is presented and the students are not provided adequate time to develop more than minimal operational skills. Jensen (1992) contends that "knowing about technology or knowing that it exists is not the same as knowing how to apply it to enhance instruction within a particular discipline" (p.1). When enrolled in teaching methods courses, pre-service teachers are uncertain as to how technology-based activities fit in. When teaching methods course instructors model the use of technology in their courses, the students receive the benefits of enhanced instruction as well as examples of the use of technology in an instructional setting in specific disciplines (Puk, 1992, Roblyer, 1989).

Purpose of the Study

The purpose of this study was to examine teacher education programs that were perceived as exemplary in providing instruction in technology for pre-service teachers in order to ascertain the degree to which technology is being integrated into the teaching methods courses. Teaching methods courses were defined as courses within the pre-service teacher education program that are designed to instruct pre-service teachers in methods of teaching particular content in classroom instruction (e.g., reading, math, science, language arts).

Several questions guided the study: Do instructors of teaching methods courses use technology in the delivery of instruction in their courses? What hardware and software technologies do they use? What hardware and software technologies do they require their students to use in the teaching methods courses? Is an introductory technology course required of pre-service teachers at their institution? If so, when is it required? If technology is not used by instructors of teaching methods courses, why not?

Methods

A nominating committee was selected for the purpose of identifying teacher education programs considered exemplary in providing instruction in technology for pre-service teachers. The nominating group consisted of 184 individuals who were members of one or more of the following: (1) presenters at the 1993 annual conferences of Society for Technology and Teacher Education (STATE), Association for Education and Communications Technology (AECT), and the National Educational Computing Conference (NECC) whose presentation dealt with technology and teacher education and whose presentations were included in the conference; (2) members of the editorial review boards of *Journal of Educational Multimedia and Hypermedia, Journal of Computing and Childhood Education, Journal of Computers in Math and Science, Journal of Technology and Teacher Education, Tech Trends*; (3) members of 1993 boards of directors of the Association for Educational Communications and Technology (AECT), International Society for Technology in Education (ISTE), or American Association of Colleges for Teacher Education (AACTE).

Members of the nominating committee were asked to identify three institutions which they believed to be exemplary in providing instruction in technology for pre-service teachers. Further, an institution had to be nominated by at least two individuals to be included in this sample of exemplary institutions. An equal number of institutions were randomly selected from all colleges having teacher education programs which were members of the American Association of Colleges for Teacher Education. Deans, chairs, and coordinators of the teacher education programs, of all institutions included in the study, were contacted to secure their consent to participate in the study and to obtain the names of the instructors of technology courses and teaching methods courses.

Survey questionnaires were sent to each of the instructors of technology courses and teaching methods courses in the institutions and the responses were tabulated. From these multiple responses, an institutional profile was constructed; if half or more of the respondents from an institution responded to a questionnaire item, that item was included in the institutional profile. Since the data types of the questionnaire items were nominal, frequencies and percentage of total responses were tabulated on each item. Chi-square tests of independence (alpha <= .05) were employed for each of the items to determine whether the differences between the exemplary and comparison groups were indeed statistically significant. Internal reliability of the instrument (.919) was established using the Cronbach *Coefficient Alpha.*

Results

Of the 36 exemplary and 36 comparison institutions selected for this study, individuals from 36 exemplary and 33 comparison institutions responded. For each of the research questions, the sample number (n) will vary depending on the response to the qualifying question. As is shown in Table 1, 100% of the instructors of teaching methods courses in exemplary institutions indicated they used technologies in the delivery of instruction in their courses.

Table 1
Do instructors of teaching methods courses use technologies in the delivery of instruction in their courses?

	Exemplary Group %	Comparison Group %	Chi square	p
yes	100.0	97.1	1.074	.300

Note: df = 1; Significance <= .05 indicated by *, n = 36 n = 33

Table 2 shows what hardware technologies these instructors indicated they use in the delivery of instruction in their teaching methods courses. The computer and the VCR is used to a great extent by both exemplary and comparison institutions. However, from that point, usage of technologies drops drastically. The only hardware technology that showed statistically significant difference was the use of e-mail and telecommunications (.032).

Table 2
What hardware technologies do instructors of teaching methods courses use in the delivery of instruction in their courses?

	Exemplary Group %	Comparison Group %	Chi square	p
VCR	100.0	100.0		
computer	94.4	90.9	.010	.919
e-mail /telecommunications	25.0	6.1	4.609	.032*
interactive video disc	22.2	18.2	.174	.677
video/video editing	19.4	36.4	2.470	.116
CD-ROM	8.3	18.2	1.472	.225
distance learning systems	2.8	3.0	.004	.950
integrate multiple technologies	0.0	9.1	3.421	.064
image/page scanner	0.0	0.0		
digitized images	0.0	0.0		
MIDI	0.0	0.0		

Note: df = 1 in all cases; Significance <= .05 indicated by *, n = 36 n = 33

Software technologies, like hardware technologies, receive very limited use in the delivery of instruction in teaching methods courses (see Table 3). Word processing is rated highest (86.1%) and instructional software (i.e., tutorials, games, simulations, and drill and practice) is ranked second (47.2%). Other software is used to a very limited degree, some not at all. Of particular interest is that the use of instructional software, desktop publishing, and gradebook programs is statistically significant (alpha <= .05) but significant in that they are used more frequently by the comparison institutions than by the exemplary institutions. Also, LOGO/LOGOWRITER is used by the comparison institutions but not used at all by the exemplary institutions in the teaching methods courses.

Table 3
What software technologies do instructors of teaching methods courses use in the delivery of instruction in their courses?

	Exemplary Group %	Comparison Group %	Chi square	p
word processing	86.1	75.8	1.207	.272
tutorials, games, simulations, drill	47.2	72.7	4.645	.031*
drawing/graphics	19.4	24.2	.233	.629
spreadsheet	13.9	24.2	1.207	.272
database	13.9	18.2	.237	.627
Hypercard or Linkway	8.3	9.1	.012	.911
desktop publishing	2.8	30.3	9.734	.002*
gradebook	2.8	27.3	8.336	.004*
presentation software	2.8	0.0	.930	.335
image/page scanning	2.8	0.	.930	.335
LOGO/LOGOWRITER	0.0	9.1	3.421	.064
other high level authoring tools	0.0	3.0	1.107	.293
BASIC/QBASIC	0.0	3.0	1.107	.293
digitizing images	0.0	0.0		
operating systems	0.0	0.0		
C+, C++, Pascal	0.0	0.0		

Note: *df* = 1 in all cases; Significance <= .05 indicated by *, n = 36 n = 33

Of the institutions included in this study only 24 exemplary and 26 comparison institutions indicated they require pre-service teachers to use technologies in their teaching methods courses. As can be seen in Table 4, the hardware technologies required of the pre-service teachers follow closely the patterns of hardware technologies used by the instructors. For the exemplary institutions, the computer (91.7%) is the only technology students are required to use to any substantial degree. Of particular interest, is the high use of the VCR by the comparison institutions (80.8%) which was also statistically significant.

Just as the above hardware technologies required of the pre-service teachers parallel those used by the instructors, the software technologies required of the pre-service teachers also follow the use patterns of the instructors. As can be seen in Table 5, word processing (83.3%) and instructional software (54.2%) are the only software technologies that are required to any great extent. The rest are required by less than 12.5% of the exemplary institutions. Again of interest is that the comparison institutions require the use of a wider range of software technologies and require its use to a greater, although minimal, extent.

Table 4
What hardware technologies are pre-service teachers required to use in their teaching methods courses ?

	Exemplary Group %	Comparison Group %	Chi square	p
computer	91.7	84.6	.588	.443
VCR	29.2	80.8	13.487	.001*
e-mail /telecommunications	29.2	11.5	2.424	.119
interactive video disc	16.7	3.8	2.279	.131
CD-ROM	8.3	11.5	.142	.706
video/video editing	8.3	11.5	.142	.706
integrate multiple technologies	4.2	3.8	.003	.954
MIDI	4.2	0.0	1.105	.293
distance learning systems	0.0	3.8	.942	.322
image/page scanner	0.0	0.0		
digitized images	0.0	0.0		

Note: *df* = 1 in all cases; Significance <= .05 indicated by *, n = 24 n = 26

Table 5
What software technologies are pre-service teachers required to use in their teaching methods courses ?

	Exemplary Group %	Comparison Group %	Chi square	p
word processing	83.3	76.9	.321	.571
tutorials, games, simulations, drill	54.2	76.9	2.880	.089
drawing/graphics	12.5	15.4	.086	.769
spreadsheet	8.3	15.4	.588	.443
database	8.3	15.4	.588	.443
gradebook	8.3	15.4	.588	.443
Hypercard or Linkway	4.2	7.7	.275	.599
desktop publishing	0.0	15.4	4.013	.045*
LOGO/LOGOWRITER	0.0	7.7	1.923	.166
other high level authoring tools	0.0	7.7	1.923	.166
image/page scanning	0.0	3.8	.942	.332
digitizing images	0.0	3.8	.942	.332
BASIC/QBASIC	0.0	3.8	.942	.332
presentation software	0.0	0.0		
operating systems	0.0	0.0		

Note: *df* = 1 in all cases; Significance <= .05 indicated by *, n = 24 n = 26

Issues Involving the Non-use of Technology in Teaching Methods Courses

Although instructors of teaching methods courses indicated that they used technology in their courses, the evidence as portrayed in this study clearly indicates this usage is minimal at best. The survey questionnaire included two open-ended items for respondents to make comments regarding technology and teaching methods courses. This was intended to provide an opportunity for the presentation of issues instructors believe to be of importance that were not addressed elsewhere in the questionnaire. The comments were read, analyzed, and grouped into categories based on the responses.

Many comments were received from the respondents of both exemplary and comparison institutions. The instructors of teaching methods courses readily admit they are not including technologies in their courses, even to the extent they believe should be included, and they supplied reasons. Three issues dominated the comments offered by the respondents. The issues most frequently presented were those dealing with 1) the need for a required technology course that was to be taken prior to taking teaching methods courses, 2) the difficulty in learning and maintaining technological skills in addition to content expertise, and 3) the need for more access to hardware and software for the teaching methods courses.

A related study of these same institutions (Vagle, 1994) found that 91.2% of the institutions do require an introductory, basic skills technology course of its pre-service teachers. It was also found that 85.3% of these institutions require or recommend the course be taken during the third or fourth year of the teacher education program. As can be seen from Table 6, the instructors of teaching methods courses believe this course should be required prior to taking their courses.

Table 6
Should there be a required technology course for pre-service teachers that is to be taken prior to taking teaching methods courses?

	Exemplary Group %	Comparison Group %	Chi square	p
yes	61.8	18.5	11.509	.001*

Note: *df* = 1; Significance <= .05 indicated by *, n = 34 n = 27

Many of the respondents expressed concern for the difficulty in maintaining a high level of expertise in their content area and also developing an appropriate level of expertise in the use and application of technology. As can be seen in Table 7, a high percentage of the exemplary institutions expressed a need for more instruction and training in technology.

The respondents also expressed the concern that although technology is provided for the technology courses and for student technology labs, there is very little technology available for the instructors of teaching methods courses. Table 8 reflects the concerns of both exemplary and comparison institution teaching methods instructors for available technology for their courses.

Table 7
Is there a need for more and better training in technologies for instructors of teaching methods courses?

	Exemplary Group %	Comparison Group %	Chi square	p
yes	88.2	51.9	9.910	.002*

Note: *df* = 1; Significance <= .05 indicated by *, n = 34 n = 27

Table 8
Is there a need for more technologies to be made available to instructors of teaching methods courses?

	Exemplary Group %	Comparison Group %	Chi square	p
yes	82.4	70.4	1.222	.269

Note: *df* = 1; Significance <= .05 indicated by *, n = 34 n = 27

Discussion

Turner (1989) stated that "few colleges of education have incorporated technology into their curricula outside of computer literacy or instructional technology courses" (p. 22). Unfortunately, nothing was found in this study to refute this statement. The institutional profiles of the exemplary institutions show that 100% of the institutions indicate they use technologies in the delivery of instruction in the teaching methods courses, but upon closer examination, the range of technologies employed are very limited.

The VCR was used extensively by all institutions in the study; the use of the computer was a close second, but from there the use of other technologies drops off dramatically. In examining the various software technologies employed, word processing is ranked very high, raising the question of whether computers are used in the delivery of instruction or in the preparation of instruction in teaching methods courses. The only other software used or required of students, to any significant degree, was instructional software such as tutorials, games, simulations, and drill and practice.

In a study of this sort, it is, no doubt, just a important to find out the "why" of the responses as it is to tabulate the quantitative information. The teaching methods instructors were vociferous in their open-ended responses regarding the non-inclusion of technologies in their courses. By their own admission, they are not including technologies to the extent they believe they should, and they provide the reasons.

Most institutions do require a technology course of the pre-service teachers. But, in not requiring this course until the third or fourth year (Vagle, 1994), the instructors of the teaching methods are given the responsibility of teaching not only the content and application of technology but also the basic technological operational skills required by the pre-service teachers. The teaching methods course instructors not only feel there is inadequate time to do this, they also believe they are not competent for the task. The result is little or no technology integrated into the teaching methods courses. Teacher education programs are on the right track by requiring a basic technology course, but it must be required earlier in the program if the use of technologies is to become an integral part of the teaching methods courses.

The instructors of the teaching methods courses are frustrated with having to maintain a high level of expertise in their content fields and the expectations of developing additional expertise in technology. They expressed a desire for more assistance from the educational technology experts on their campuses in developing more hardware and software expertise. It would seem that a cooperative, collaborative team approach might provide assistance for the teaching methods instructors and provide realistic, relevant projects and content matter that could be incorporated into the technology courses by the instructors of these courses. It would also be possible to more closely coordinate the instruction of certain technologies in the technology courses with the application of these technologies in the teaching methods courses.

The third area of concern was the unavailability of technologies for the teaching methods courses. A wide variety of technologies are provided for the technology courses and the students technology labs but are usually not available for the methods courses. It is also difficult, sometimes impossible, to schedule student labs for use by the teaching methods courses because of heavy demands by the technology classes. Cuban (1986) has traced the fate and failure of technology largely to the lack of access. Training for the teaching methods instructors and requiring technology courses for the pre-service teachers, prior to taking methods courses, will not solve the problem of non-inclusion of technology in the teaching methods courses if technologies are not available for the instructors to use in the delivery of instruction.

Summary

This study has provided evidence of the lack of inclusion of educational technologies in teaching methods courses. The study has also provided some of the reasons for the non-inclusion that have been offered by the instructors of these methods courses. There are still many unanswered questions: 1) are there other contributing factors that are impediments to the inclusion of technology into the teaching methods courses? 2) Do the instructors of the teaching methods courses possess certain attributes that inhibit this inclusion? 3) Do instructors of teaching methods courses perceive value in the use of technologies in the teaching and learning process? 4) Are there models of collaboration and cooperation between instructors of technologies courses and teaching methods courses that provide exemplary experiences for pre-service teachers? 5) Do institutions that have distinct and separate educational technology departments provide for higher levels of technology instruction and integration throughout the teacher education program?

Effective use and integration of technology throughout the teacher education program is dependent on the instructors of the teaching methods courses. The technology courses must help prepare classroom teachers who are capable and competent in utilizing a multitude of learning resources — technological and traditional. The means for achieving this objective requires a collaboration among all teacher education instructors but particularly instructors of technology and teaching methods courses. The pre-service teachers and their future students will be the winners!

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The Uses of Hyperstudio

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The integration of technology into pre-service secondary education curriculum courses requires a review of the uses of the technology in schools. Technocrats see technology as a tool to help teachers in the daily management of the classroom (Schuttloffel, 1994) and as a substitute for the teacher as information deliverer (Wentworth & Connell, 1994). Visionary reformers see technology a catalyst to an expanded view of instructional practices (Salomon, Perkins, & Globerson, 1991) and as an agent for massive system reform for schooling, (Papert, 1993). Each of these roles of the computer is an important one in the marriage of technology and education, and each should be the focus of experiences the pre-service teacher has with technology. As teacher educators embrace one and ignore the other, their students (pre-service teachers) might miss the connection to technology that would allow them to embrace both uses of technology. In pre-service education courses prospective teachers need to be exposed to both uses of technology and the appropriate application of each.

In this study, pre-service teachers in a secondary education curriculum course were exposed to technology as a tool in classroom management and information delivery, and as a tool to change the nature of learning and teaching in the classroom. Initially the students were introduced to a Hyperstudio stack which reviewed the basic content of the course and ended with a set of test questions that was scored and recorded by the computer. Students were allowed to respond in an essay box (text field) about the value of technology applications in the classroom. Then they were asked to design an interdisciplinary activity over a three week period that would include their future students in an authoring system like *Hyperstudio*. If they were not familiar with *Hyperstudio*, the students were encouraged to explore the *Hyperstudio* tutorial to learn how to create a stack, buttons, fields, etc. The focus of the use of technology shifted from the management and information delivery model to one in which technology was used to change the nature of instruction. After each of these activities, the students were asked to comment about the uses of technology in the classroom, how valuable the experience had been for them, and how this might impact the ways in which they might use technology in their future classrooms.

Technology as aTtool for Management and information delivery

The Hyperstudio stack used to review the content of the curriculum course included an introductory card with several aspects of classroom issues represented as buttons. There was a grade book to represent evaluation issues, a blackboard to represent curriculum and instructional issues, several students to represent adolescent development issues, and a chair in the corner of the room to represent classroom management issues. Each object was a button that, when clicked, would send the student to different cards in the stack with further information about that issue. Some of the areas were purposely not completed so that students could create cards themselves to show what they understood from the readings about that particular curriculum area. Each issue had a test that could be selected by the student as a review of how well the student understood that material. Each student was given a disk with this stack on it and was asked to go through the program including all the review tests and return it to the teacher. Before the student could exit and save the stack with his or her review test scores on it, a comment box appeared on a card. Most of the students typed in their reactions to the tutorial.

The pre-service teachers had many positive comments and some negative remarks about the tutorial and management component of their experiences with technology. Several students made comments suggesting that tutorials allowed students to focus their attention on the material and learn in a non-linear way, while other students felt that this was a superficial way to learn material and that it would soon be forgotten. Many students commented on the value of the computer grading and recording the scores for the teacher. They thought this would free their time for other work with students. Some examples of these comments were:

- This simple school program is just one example of how information can be organized to make learning easy and fun.
- The student cannot zone out as easily because he or she must follow the instructions which are being given by the computer or be actively involved in some other way.
- I like the classroom scene in this program because it allows the learners to explore areas of interest to them; it does not force them to learn things at a certain time.

One student identified a major concern over testing with computers at the end of the tutorial when he said, "I see a problem with people simply learning or memorizing the information needed to pass a quick test at the end of a program because that is what I just did. If I were tested tomorrow, I am pretty sure that I would not remember anything."

Technology as a Tool for Educational Change

Along with the *Hyperstudio* tutorial, the pre-service teachers were assigned an interdisciplinary curriculum project in which they were to design instruction covering a three to five week school period. The design was to include whole-group, interdisciplinary activities as well as individual class content work. The pre-service teachers were given a *Hyperstudio* stack as an example of how to engage students with content and were asked to use this example as a way to represent their project to the rest of the class. They were placed in groups of 4 to 6 students and asked to pick a theme for the group work. These could range from general topics such as communication, revolution, or transportation to current events such as the Olympics, public elections, etc. They had previously calendared the specific course material they would need to cover in their individual content areas so any group work would have to come out of that time. They were also asked to have their content work apply to the theme when possible. They were asked to keep track of the number of hours used to complete the *Hyperstudio* stack in a journal along with their concerns, frustrations, successes, etc. during the project.

Some students were very intimidated about using *Hyperstudio,* but after completing the tutorial, the students had the confidence to explore the use of *Hyperstudio* and do some authoring as part of the larger curriculum assignment. One student commented, "I've loved doing the computer portion of our curriculum assignment — which really surprised me at first since I haven't worked on computers very often, and I was scared to begin the computer project." Another student said that no one in her group had ever done anything with computer stacks before, but she and her group were able to complete their stack in just about 8 hours. No group took longer than 30 hours to complete the computer portion of the curriculum project. The average was about 12 hours. Some students did have more experience than others with *Hyperstudio* so they were very helpful in creating the stack while other students worked on the curriculum design.

Some projects looked very much like a tutorial program that the pre-service students wrote for their students to go through. One student recognized that this requires a great deal of time for the teacher with minimal benefit to the student when he said, "I don't see the 30 hours spent on writing it as being the most effective use of time for an instructor. I think programs should become available to teachers so that they don't have to compose programs unless they wish to." He missed the point of having the computer be a new way to engage students in learning. The students should write the tutorial, or create some other project that requires them to integrate the knowledge into a final piece of work. These comments were made to him so that he might understand the appropriate way to use technology to engage students in learning.

Many of the groups caught the vision of using the computer to change instruction. A group of five students combined the areas of geography, biology, history, art, and dance by asking their students to discover an island including a written history, written culture, visual artifacts and visual representation of their native, a native dance, plant and animal life on the island and the geography of the island. One group member wrote,

"Our group project has turned out to be really neat. If I were a student I would love to do it! Our idea and theme is discovery and we have created a program that allows our students to create their very own island. On this island, they will have to design the people and their color, the size of the island, their flag, and describe their culture and life styles. So they apply all the things we have worked on in their classes during our five week interdisciplinary period."

This group used *Hyperstudio* to create a shell for the students to complete on the computer. From the shell the students would represent with computer graphics, sound, video, etc. their island. The evaluation of the project would center around the likelihood of the animals and plant life supporting each other and the culture created by the students, etc. This project combined many different content areas into a creative exercise for students. The future students of these pre-service teachers will have the experience of integrating many ideas and facts learned traditionally into a final project of their own creation. Instruction will have moved from information delivery and management into a dynamic process of creation for the students.

Results

The pre-service teachers were exposed to both a management and information delivery use of technology and a creative instructional use of technology. The students seemed to understand the different uses of technology when exposed to them in both of these ways. They were able to recognize the different values of the two uses of technology in classroom instruction and curriculum design. They saw how the design of an activity that would engage their students in creating a *Hyperstudio* stack was very different from the tutorial and management use of the computer. Many comments illustrate that they understand the differences:

- I feel that computers should improve interactive learning not by doing traditional school activities on expensive equipment.
- I think the computers can encourage students to be more creative.
- I think it's very important to assess why you will use one [a computer]. If it's just to add variety or give students "play" time, rather than really enriching their learning, I think they can be a big waste of time. I think computer application can be beneficially used in the classroom.
- Too often the programs become just drill and practice or page-turners and fail to really test a student's knowledge of material. As educators we need to take an active role in changing this idea of computers and really try to make use of good programs in our classrooms.

The use of *Hyperstudio* was important to the project because it allowed the pre-service teachers to focus on a non-linear approach to topics. As they selected group activities to present to their students, they built stacks in *Hyperstudio* that allowed their students to see connections from the theme to their content area. The pre-service teachers included assignments for their students that asked them to design *Hyperstudio* stacks that were interactive and non-linear. The pre-service teachers kept track of the number of hours put into the *Hyperstudio* stack design. This helped them realize how much class time to allow their students to have for authoring their *Hyperstudio* designs. They reported that initially they had difficulty anticipating what buttons would be needed, what should be in the background of the stack, etc. As they became more familiar with *Hyperstudio*, not only were they able to complete a stack more quickly, the design and flexibility of the stacks were much more interactive and non-linear. The pre-service teachers also reported in journals how difficult they thought an interdisciplinary unit would be to do but that with Hyperstudio they could see the connection of many different content areas.

Conclusions

It is not enough to tell students the different uses of computers in the classroom and explain the strengths and weaknesses of each. It is important to give students exposure to both management and information delivery uses and creative instructional design uses of computers in the classroom. The exposure to management and information delivery uses allowed students to see that technology can be an expensive way to do traditional teaching. Exposure to creative instructional practices with technology allowed the students to learn that this use of technology requires a new vision of education and classroom practices. From these experiences students will have the ability to judge for themselves the appropriate use of technology in the classroom. Their experiences will give them the necessary vision that will allow the marriage between education and technology to happen.

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New Directions for Teacher Education in the Information Technology Age

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Societal changes have occurred as a result of the information age, and concomitant changes have also occurred in all levels of education. The role of the classroom teacher is evolving from that of a giver of information to that of a facilitator of student learning. Thus, we are witnessing a shift in the paradigm of the teacher to that of information manager. The implication for teacher education is that preservice teachers should be trained in both the processes and products of technology-based instruction.

Teacher education in the utilization of technology should have an instructional focus (Persky, 1990). In addition to the operational aspects of information technology, preservice teachers should be able to integrate technology within the curriculum to achieve instructional objectives. However, Wiburg indicates that the major block to incorporating technology "... is a lack of shared educational models" (1991). The purpose of this paper is to share the model used at Georgia Southern University for integrating the processes and products of instructional technology with teacher education courses in curriculum and methods.

Course Design

The College of Education at Georgia Southern University has three distinct courses in instructional technology to meet the needs of preservice teachers in Early Childhood Education, Middle Grades and Secondary Education, and Exceptional Child Education. The faculty in each of the three program areas and the faculty in the Instructional Technology program worked together to design the content of these courses as part of the professional requirements for certification.

The design of the instructional technology courses was guided by three principles: (1) the activities in the courses would be linked with activities in other teacher education courses, (2) technology would be incorporated throughout the courses as a tool for production, selection and utilization, and (3) the activities in the courses would integrate the information technology resources of the university, the campus laboratory school, and schools in the local district. Although each of the courses was modeled on these three principles, each differs in terms of placement in the teacher education program of study, specific course content, and course requirements.

Early Childhood Education

The Early Childhood preservice students take the Introduction to Instructional Technology course in conjunction with the required curriculum course in the professional core. This requirement occurs at the very beginning of the Early Childhood program of study.

The design of this course is the result of direct consultation with the faculty in the Early Childhood program area. The course is continually updated to reflect changing needs as identified by the faculty. Public school teachers and administrators are periodically surveyed to determine their perceptions of technology needs of beginning classroom teachers. In addition, feedback from student evaluations are implemented into course revisions.

The instructional technology course designed for the Early Childhood majors includes basic production techniques, equipment operation, video operation, multimedia technologies, media selection strategies, and applications of computer technology in all aspects of instruction. The students learn these skills in the instructional technology class and practice the skills in a lab setting. The students in the Early Childhood Education Introduction to Instructional Technology class are then expected to complete projects that demonstrate their competency in these skill areas. After the students have completed the activities in the technology course, they use these newly acquired skills to complete projects in their core curriculum course. This continuous reinforcement provides students with distributed practice so that they are more likely to master the skills and remember the procedures involved. This procedure also gives students an opportunity to see various applications of different skills.

Middle Grades and Secondary Education

The course, Instructional Technology for Middle and Secondary Schools, is sectioned separately for middle grades and secondary education majors and is taken for 3 quarter hour credits. The middle grades section is coordinated with the block courses in social studies methods and language arts methods. Students plan and teach a two week lesson to lab school classes utilizing the concept of team planning with an interdisciplinary theme. The section for secondary education majors is coordinated with activities in their respective subject area methods course. The students plan and teach mini-lessons with both their peers and lab school students.

The activities of the IT course are incorporated as students design their lessons. Once they have received their topic and developed the instructional objectives, students use on-line searching techniques to locate resources in the Marvin Pittman Laboratory School Media Center. Then they utilize equipment and evaluate items such as computer software, videos, slides, and filmstrips in relation to their instructional objectives.

Computer software programs are demonstrated which assist them with the production of handouts, worksheets, tests, and overhead transparencies. It is stressed that such local production allows teachers to design materials which match exactly with instructional objectives. Each student is required to produce a handout and an overhead transparency which supports the lesson being taught.

Other technologies which are explored are CD-ROM, video laser discs, camcorders, distance learning, and telecommunications. Students conduct an on-line search to locate journal articles which describe practical applications of these technologies in their respective subject areas and grade levels.

The evaluation of student work is based on both the quality of the IT lab work (products) and the instructional design for incorporating technological resources (process).

Exceptional Child Education

The third course, Instructional Technology for Exceptional Child Education , is designed for preservice Special Education majors. The course occurs about half-way through their program of study and is taught concurrently with their methods course in Special Education.

Unlike the other two courses in Instructional Technology, the primary focus of this course is computers and related technologies; very little time is spent covering the production of instructional materials. The major emphasis is the integration of technology into the special education classroom and integrating the technology with Individual Education Plans.

Course topics include word processing, databases, spreadsheets, graphics, hypermedia, multimedia, and software evaluation. Through hands-on labs students are exposed to both the administrative and instructional functions that special education teachers perform. Special emphasis is given to meeting the individual needs of special learners through the use of technology.

Continuing Development

Because of the changing nature of technology, it is important to seek constant input to determine current applications of technology in education. The Instructional Technology program area relies on input from a variety of sources to determine goals and objectives for the technology courses. Public school practitioners and college faculty are consulted to determine current needs of preservice teachers in technology related skills.

A survey was administered to public school administrators, media specialists, and teachers to identify technology skills that beginning teachers should have. Based on the results of the survey, the above listed public school personnel consider all of the content areas currently included in the undergraduate technology courses as important skills for beginning teachers.

College faculty are consulted on a regular basis for input. Plans are already developed to merge the technology skills of public school personnel and college of education faculty. During the coming academic year, public school personnel will serve as consultants to identify applications of technology in the K-12 classroom settings. It is the intent of this project that college faculty will increase the use of technology in the methods courses that are required for preservice teachers.

Conclusion

If we are to look to future teachers as change agents in the implementation of technologies into the schools, we need to verify that they are prepared with the skills necessary to bring about these changes. In addition, students need the opportunity to evaluate different innovations that can be used with current and emerging technologies.

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Integrating Technology into the University Teacher Education Curriculum in Music

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This paper offers a discussion and demonstration of teaching methodologies that integrate software and hardware into university teacher education in music. Problems and successful solutions in software, hardware, and multimedia methodology for teacher education in music are examined.

Undergraduate Teacher Education in Music

The undergraduate teacher education curriculum instructs students in a particular subject area and educates them in effective teaching strategies, all within a four year period of time. Although considered a single major, such a curriculum is a double major, and students who successfully complete the program graduate with two specialties. Undergraduate teacher education students in the performing arts - and especially in music - must achieve major physical skills development in order to successfully use their craft as performing artists. These students graduate with substantial credits in three areas of concentration: subject knowledge, teaching knowledge, and performing arts skills.

Undergraduate music teacher education students find their time divided among courses in general studies, music, and teacher education. Music study includes individual applied music and many hours in large music ensembles such as marching band, choir, orchestra, and wind ensemble. Time is also given to smaller ensembles with two to five members. Often the demand on these students' resources is overwhelming and leaves little or no time to pursue personal or academic interests in depth. Undergraduate teacher education in performing arts presents an important opportunity for computer technology to play a role in the learning environment.

The advent of computer and software technology for instruction and learning is current with the increasing demands on program evaluation and competency requirements for undergraduate students in teacher education. In North Carolina and in other states competency requirements for teacher licensure include skills with computers and software that address the everyday needs of teachers. The ability to word process, produce printed materials, establish and maintain student records and grades, and produce administrative reports with computers and software must be taught. If future teachers will be prepared to use this technology in their own classrooms, using computers and software for instruction and learning must become an important part of undergraduate teacher education in all areas of concentration.

Another important area of technological impact on teacher education in the performing arts is the use of computers and software to instruct students themselves during their own undergraduate studies. This area has developed quickly in over the past several years so that now most performance skill subjects have technological solutions. Courses that train music students to listen, hear, understand, and reproduce the music they have heard (usually called ear-training and sight-singing) can often be taught with a laboratory approach using computers and software. Notating music, previously taught as calligraphy, is now accomplished by using sophisticated software, computers, and laser printers. Applications like *Finale* from Coda Technologies, used in professional publishing houses, enable students to achieve similar professional results.

In summary, the impact of computer and software technology in music undergraduate teacher education falls into these areas: 1)teaching the skills mandated by state licensure requirements; 2)teaching the skills necessary for satisfactory course performance; 3)teaching students to use and create instructional software for their own later uses in teaching; 4)using computers and software for undergraduate course instruction; and 5)using computers and software to supplement course instruction.

Graduate Teacher Education in Music

Teacher education in music at the graduate level involves research at levels not usually explored by undergraduates. Graduate students commonly engage in on-line research and access ERIC Digests, university libraries, and other sources via the internet. This requires knowledge of Gopher, Mosaic and other World Wide Web browsers, and Fetch. They may also participate in Listservs and newsgroups which are electronic discussion groups. When given a topic for investigation, graduate students typically consult others who may be researching the same topic by using electronic mail, posting to newsgroups, etc. Only after seeking this assistance do they enter the library. Information gathered in this manner gives graduate students a head start and saves many hours of effort.

Graduate students in music teacher education are motivated to improve skills previously gained and to find solutions for problems presented during their professional classroom experience. They understand the efficiency of new technology and how it may have an immediate impact on their teaching. They readily absorb CD-ROM technology, computer projection for classroom presentation, multimedia courseware creation, and the many uses of MIDI (*Musical Instrument Digital Interface)* for student instruction. For example, graduate music education students in areas such as band and orchestra teaching are interested in learning how to create MIDI files for their students to use in rehearsing solo or ensemble music in the absence of accompaniment or other instrumentalists. They use synthesizer and sequencing technology to create methodology that offers immediate improvement in their own students' skills. This improvement is often reflected objectively in higher performance ratings at district or statewide competitions. Many graduate music education students choose a technology based project for the final presentation required by the graduate music degree.

Teaching Methodology

There are many benefits to integrating technology into instruction. Traditional lectures can be replaced by computer presentation that places the learner in a more direct relationship with the course material. This methodology encourages the teacher to become a guide who illuminates and explains, who offers learning in a non-threatening, self-paced environment, allowing students to accept personal responsibility for their own learning and mastery of material without instructor dependency. As faculty achieve expertise in developing their own multimedia software solutions and in using commercial applications to integrate computer technology into instruction, they become advocates for increased student use of technology in the learning process.

However, many faculty members experience problems common to a shift in paradigm. In some cases, they have refused to accept new technology for teacher music education instruction. Other faculty teach as though computer technology were just another classroom peripheral. Some faculty use computers and software to supplement a lecture. Faculty who successfully integrate technology into instruction make a commitment to teach with technology - to use its strengths and to allow for its weaknesses.

Merrill (1987) offers a theory of instructional design based on one fundamental assumption and four basic principles. His *Component Design Theory* assumes that learning tasks can be categorized and their accomplishment measured. Cognitive structures must be consistent with learning outcomes and a direct relationship exists between the intrinsic structure of concepts and their purpose. He proposes that *Elaboration Theory* guides course design while *Component Design Theory* guides the order of lesson-level instruction. He states that careful and deliberate guidance through instruction in necessary but that the learner should assume greater control over that guidance as learning progresses. His final point is that the learner needs ample time and opportunity to practice new concepts and skills in a dynamic, responsive, and monitored environment. It is the involvement of the learner with the system that provides learner control, suggests learning strategies, and gives guidance. True interactive instruction involves frequent and complex transactions between learner and system. A more complete discussion of Merrill's theories is given in Johnson & Foa, 1989.

It is the last two points that particularly interest anyone concerned with how technology can be integrated into instruction. If we accept Merrill's proposition, students must be guided; they must begin to take control over their own learning; they need plenty of time to practice; they need an environment that is conducive to interactive learning. Anyone involved with instruction using software realizes that it can be more time consuming than more traditional classroom instruction. Teachers generally need more preparation time, although someone proficient with software may be able to create a simple interactive instructional module in the same time that it would take to make some handouts and overheads. Students have to exercise enough discipline in time management to allow for consistent use of technology on a daily basis. Interactive instruction and learning does not easily support last minute cramming! For this reason students sometimes do not react positively to course requirements that stipulate computer lab time. However, experience demonstrates that the students realize the depth of their understanding of and control over the material can be greater than in other courses which utilize more traditional methodology.

Integrating Technology into Courses for Teacher Educators

The School of Music at East Carolina State University has a long association with new developments in technology. The Electronic Music Studio began in 1970 and The Center for Music Technology was established in 1990. A second MIDI computer lab in the School has been established around KORG C-46/56 Concert Pianos and Macintosh Quadra 660 A V computers. This technology has changed student expectations for presentation of course material in teacher education and enabled faculty to use computer and MIDI technology for instructing music education majors.

Early Experiences

The undergraduate music teacher education curriculum at this university includes a two semester hour course that gives students observation experiences before gaining upper division admission to the teacher education major. Over the past several years this course in the School of Music (*Early Experiences, MUSC 2133*) has taught students divided into two groups. The students alternate between observation experiences and intensive personal experience in using computer and software technology, spending one half of the semester in each area. During the first eight weeks of the semester one group observes and evaluates in actual K-12 classrooms while the other group receives instruction and practice with computers and software. At mid-semester the groups exchange places. In previous years the students received instruction in the use of Microsoft Works. They used this program to create letters and fliers, keep student records in a database, and compute student attendance, assignments, and grades using spreadsheets. This year students are also learning to use HyperCard as a tool to create their own interactive instructional software.

Teaching methodology in this course is simple. The electronic classroom used makes it possible for students sitting in front of their own computers to follow verbal instructions and electronic LCD panel projection from a master computing workstation. Instructor techniques include constant timing adjustments so the flow of information does not exceed each student's ability to follow; constant monitoring of students' screens to ascertain individual progress; using the mouse as a LCD pointing device; and utilizing a very helpful graduate assistant who responds to raised hands (as does the instructor) for further clarification. Merrill's (1987) *Component Design Theory* is confirmed by the results obtained in this class. Students, after minimal guidance, do take control of their own learning and use available lab hours to practice in a quiet environment conducive to learning. Expectations presented by the instructor are linked to acquisition of technique with the software and computer being used, so success and positive response occur before the next task is attempted.

Sight-singing and Ear-training

The ability to remember and recreate music - to hear music and see notation in one's imagination - is basic to every area of music instruction and learning. Students in music teacher education have the additional responsibility of learning methodology for communicating these skills to their younger students in the K-12 setting. Fortunately, software is available that increases the acquisition of these skills. At this university such skills are taught in a four semester course sequence entitled *Basic Music Skills* with a correlated lab section for each course. In the lab students typically rehearse their ability to vocally repeat or reproduce musical material provided by the instructor, usually the instructor's own voice or from the piano keyboard.

Software applications used with great success by professors in *Basic Music Skills* classes include *Music Theory Tutor* developed by Janis Kindred at Stetson University and *Practica Musica* from Ars Nova Software. The ear-training labs now use a new application, *Claire, the Personal Music Assistant*, from Opcode Systems. *Claire* is, in one word, fantastic. This software is for what music instruction has been waiting since the world of interactive courseware opened the classroom to "complex transactions between learner and system" (Merrill, 1987). *Claire* offers complete interactive guidance and instruction on a Macintosh computer for practicing repetition and evaluation of musical tones, phrases, and melodies. After adjusting itself to the individual student, it evaluates student vocal responses to one-sixth of a step.

Music History

Music history is taught to all music teacher education students in a five semester sequence that presents both a chronological survey of music and an in-depth analysis of specific musical works. Student involvement in this and similar courses traditionally includes assignments for personal listening to musical compositions to "learn" them. That is, they must be able to recognize and identify a composition when any part of it is heard. This often requires hours of concentrated repetitive listening while taking notes to aid memory and identification. Students are observed at listening stations in the music library reading or otherwise occupying their time while performing the listening necessary to complete such assignments. Since the neighboring computer lab and the KORG Learning System Lab upstairs include CD-ROM players with each computer, they are encouraged to bring their CDs into one of the labs and listen there.

Many CD-ROMs exploring music are available from the Microsoft, Voyager, and Warner New Media companies. Titles such as *Musical Instruments, Beethoven's String Quartet No. 14, Stravinsky's Rite of Spring,* and *Strauss' Three Tone Poems* are commonly available. The set of four videodiscs from the University of Delaware is one of the most useful tools for support in this type of course. This set includes many musical examples with scrolling score views as well as supporting information about composers and other musical compositions. One of the most useful areas of these discs is the exhaustive slide show included on each disc. However, instructor and student access to this material has been difficult. Without a laser disc player attached to a computer for serial device control, it has been impossible to use the disc set for teaching. Students use by more than one student at a time has been impossible since there are not numerous laser discs included in a typical computer lab situation.

Our solution to the problem of using these discs was to create a series of HyperCard stacks that used the Voyager CD-ROM tools to give immediate access to the laser disc information while at the same time providing video captured images of each slide on the discs. These stacks are topically arranged for general information and composer information. There are stacks for C.P.E. Bach, J.S. Bach, Beethoven, Brahms, Haydn, Mozart, and Schubert. Each stack contains cards with images (one per card) and text explanation together with tools for viewing the same image by laser disc projection if available and for controlling CDs inserted into the CD player attached to or inside of the computer. It is this last capability that has proven most successful for students. They will bring their listening assignments into the lab and view the HyperCard stacks with slide material while performing their specific listening assignments.

For class use both labs have laser disc players attached to master computer workstations and large TV type monitors. While discussing a composer or composition, the instructor may simply mouseclick on an item listed on the Index card in each stack to present the item on the master computer, then mouseclick on the button titled "Play Laserdisc" to see it viewed on the larger monitor by the entire class. In this way the entire content of the slide show on each disc is available to illustrate important points during a class presentation.

The way in which these stacks were created illustrates an important point in this topic of integrating technology into instruction: students often are way ahead of their professors! At the beginning of this past summer, a group of graduate assistants assigned to work in our computer lab sat down with me to discuss summer projects. We collected syllabi for all courses taught in the music school. After looking through them a mutual decision was made to support the music history sequence by making the information on these laser discs more readily available. After a few hours of instruction of video capture and image manipulation with software, the graduate assistants moved ahead on their own with the basics for this project. Since I served as the faculty member in charge of this project, I provided the HyperCard stack format and all the details of stack organization and scripting. Applications used besides HyperCard 2.2 were Adobe Photoshop 2.5, Apple's Video Monitor, and FusionRecorder. The hardware was a Macintosh Quadra 660 A V computer attached through a serial port and cable to a Pioneer 4200 Laser Disc Player. The students all agreed that this project was a very worthwhile way to spend their time in the lab when not monitoring student use.

Music Notation and Printing

Music teacher education students quickly find that learning to use technology for creating music notation and printing musical examples is one of the most valuable skills they have acquired. An elective course is available that teaches the use of *Finale* from Coda Technologies. Several professors teach beginning *HyperScribe* skills in the *Basic Music Skills* courses. *Finale* uses MIDI output from a synthesizer attached to a computer to interpret performance data sent to the computer through the MIDI interface. Parameters like timing, speed, duration, pitch, attack, and release are all incorporated into the datastream evaluated by *Finale* to create accurate music notation that may be printed on one of the available laser writers.

Other Courses

Music teacher education students may elect to take additional courses entitled *Introduction to Music Technology* and *Multimedia Music Courseware Development* to complete their own familiarity with the methodology for integrating computers and software into instruction. Students who return for graduate level work agree that this is one of the most useful capabilities of technology and the one that has the greatest impact on their daily professional lives.

Conclusion

The impact of computer and software technology in music teacher education at the university level is important for teaching students to use and create instructional software. Courses in *Early Experiences, Basic Music Skills, Music History, Music Notation and Printing,* and *Music Technology* all play an important role in preparing music teacher educators at East Carolina University. They are successful examples of integrating computer and software technology into the teacher education curriculum.

Students need to learn the skills necessary for satisfactory course performance, but they must also learn how to use computers and software for course instruction and to supplement course instruction. Merrill's *Component Design Theory* (Merrill, 1987) offers a lucid framework to develop course instruction that integrates the use of technology and the nature of true interactive instruction and its implementation.

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Designing, Developing, and Evaluating a Laserdisc Program for English/Language Arts Teacher Education

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What a middle and high school English/language arts teacher teaches as well as how it is taught are issues that have historically generated controversy and change in American curriculum (Applebee, 1974; Berlin, 1987). Current debates concern issues such as whose literature constitutes the canon, what skills should be taught, and what theoretical and ideological assumptions underlie pedagogy (Elbow, 1990). This paper addresses a topic that has captured the interest of educators: the reading/writing workshop approach (see Atwell, 1987, and Rief, 1992, for a detailed description of the approach). Tenets of the workshop approach call for a constructivist learning environment. That is, the reading/writing workshop classroom is a student-centered milieu in which reading and writing are taught holistically in meaningful literacy events.

As with other professional education, a number of publications and textbooks are available for helping pre-service English/language arts teachers and teacher educators explore the various perspectives on the application and practice of the *workshop* approach. The education of these future teachers could be enhanced, however, through the use of video-case instructional support programs. Video-cases provide a macro-context, a rich environment through which students can re-examine and cross-examine scenes and cases for different reasons (Risko, 1991). Video presentations capture "linguistic expressions plus visual and other auditory information. . . .There is much to notice within the presentation. Increasing opportunities for noticing can increase the possibility of finding information that leads to problem identification and problem solving" (Risko, 1991, p. 133).

The random access capabilities of laserdisc technology make viewing scenes for different reasons quick and convenient. Interactive laserdisc programs make possible the incorporation of video with text, sound, and graphics, merging the potential benefits of learning in the real-world with those of learning in the classroom. A review of the literature confirms that video-case based laserdisc instructional programs that (a) are specific to the professional development of English/language arts teachers, and (b) focus on the application and practice of the reading/writing workshop approach have not yet been designed and developed.

This paper will briefly describe the process of designing, developing and evaluating an interactive video-case based instructional support package for use by professionals-in-training who are exploring the application and practice of the reading/writing workshop approach. The prototype of the hypermedia program named *Literacy Education: Application and Practice (LEAP)* has three major components:

1. A laserdisc containing video-cases of three experienced, middle school teachers who use the workshop approach.
2. Software that allows learners to explore, analyze, and critique precepts of the workshop approach from various perspectives.

3. A collection of seminal literature concerning the underlying theory and current practice of the reading/writing workshop.

Research Questions

Three research questions were framed to guide the design, development and evaluation of LEAP:

1. What are the design features of LEAP, a hypermedia instructional package that (a) focuses on the reading/writing workshop approach and (b) is targeted for use in English/language arts teacher education?
2. What procedures are involved in the development of a prototype of LEAP?
3. What changes in perspectives related to the teacher's role, student's role, and learning environment of an English/language arts classroom are revealed in the observations of and interviews with teachers-in-training as they interact with LEAP?

Procedures

The methodology for this study is a modified application of the educational research and design cycle developed at the Far West Laboratory for Educational Research and Development (Borg, 1970). The cycle includes ten steps; however, only the first four were used for this study:

1. Research and information collection—review of literature, small-scale research studies and preparation of report on state of the art.
2. Planning—defining skills to be learned, stating and sequencing objectives, identifying learning activities, and small-scale feasibility testing.
3. Develop preliminary form of product—preparation of instructional materials, procedures, and evaluation instruments.
4. Preliminary field testing —conducted in from 1 to 3 schools, using 6 to 12 subjects; interview, observational, and questionnaire data collected and analyzed.

This model was modified in two ways: (a) the procedures for production did not always follow the four listed steps consecutively; instead, the four-step process was recursive, and (b) instead of defining specific skills and objectives to be measured, general and tentative goals were established.

Determining the Features of LEAP - Gathering Information

Needs Assessment

Input from teacher educators including Dr. Jerry Willis at the University of Houston, where LEAP was developed, and Dr. Linda Roff at Houston Baptist University, the field-test site was sought. The purpose of initial interviews included the following:

1. Review reading/language arts programs at Houston Baptist University.
2. Brainstorm ideas for the creation of a technology-based product to enhance their program.
3. List professors at Houston Baptist University who might incorporate the product in their classes.
4. Review syllabi of the selected professor's upcoming courses and discuss the size of classes, type of students, and typical classroom activities.
5. Discuss possible directions for design and development, look at existing curriculum of selected course, and consider ways in which the reading/writing workshop could be integrated into an existing curriculum.

The Reading/Writing Workshop

The workshop approach blends literature, writing, language, and speaking into a literacy event that closely resembles the literacy-based activities of society outside of school. From the works of the leading proponents such as Atwell (1987), Reif (1992), and Romano (1987) the following principles for workshop teachers were liberally abstracted.

- The reading/writing workshop teacher is not the expert or source of the "correct" knowledge, but rather is a facilitator, mediator, and mentor for each student.
- The reading/writing workshop teacher reads, writes, and learns with the students.
- Reading and writing are not considered separate subdisciplines of language arts.
- Reading/writing workshop students can be trusted to construct and direct their own learning.

Although these generalizations serve to weave the various proponents' visions into a unified fabric, they are too broad to convey the meaning of practicing the workshop in a classroom. Because the reading/writing approach to teaching literacy varies from case to case, exposure to how various teachers have applied it in their particular classrooms would be valuable to pre-service teachers. Perhaps the ideal exposure would come from multiple observations of different classrooms where the approach is used. For most colleges of education, such a plan is impractical. Reading case studies is another alternative, but it does not provide the richness of information that can be gained from observing the dynamics of a live context. Video-case methodology provides the advantages of live observation of the classroom and is a practical and convenient instructional tool.

Cognitive Flexibility Hypertext

Several interactive video-case programs for teacher education are described in the literature, most of which are based on constructivist theory (see Abate, 1994, Benhiat & Abate, 1994, Randolph, 1991, and Risko, 1991 for examples). Of particular interest to the design of LEAP is Knowledge Acquisition by Nonlinear Exploration or KANE (Spiro & Jehng, 1990). Although this program is not specifically designed for teacher education, it is designed for advanced knowledge acquisition and cognitive flexibility—the ability to successfully transfer knowledge from case to case particularly when cases are not identical. KANE is based on the film Citizen Kane and is designed to guide high school and college students through the application of literary themes apparent in the character development of fictional publishing mogul Kane. Spiro and Jehng (1990) contend that very short pieces of video, or mini-cases, on

273

laserdisc combined with hypertext create a rich environment for the exploration of complex, ill-structured domains such as medicine, history, engineering and literature. Spiro calls this learning environment Cognitive Flexibility Hypertext.

The reading/writing workshop approach is a complex domain that can be characterized as having case-to-case irregularity. Students exploring the approach may become more comfortable with its complexity and be better prepared to apply it if they are cognitively flexible. To design the features of LEAP, KANE was studied as a model. The particular features that were applied to LEAP are mini-cases, themes, opportunities for theme-based exploration, expert commentary, and a variation of KANE's theme-combination exploration component.

Mini-cases. Mini-cases allow for a guided, nonlinear, and multi-dimensional analysis of larger cases and allow for an early introduction to advanced complex situations by presenting them in manageable, bite-size chunks (Spiro & Jehng, 1990). The mini-cases in LEAP are video episodes of student-teacher and student-student interactions that occur in classes taught by experienced middle school teachers who have been trained in the reading/writing workshop approach. Preservice teachers can view these from a laserdisc.

Themes. Themes promote multiple representations of knowledge. Multiple representations such as that provided in KANE's ten themes relating to Kane's character strengths and flaws maximizes transfer because the student becomes aware that no single interpretation can be imposed. The themes in LEAP reflect basic principles of the reading/writing workshop approach as they relate to the teacher role, the student role, and the environment. Several subthemes accompany each theme. For example, subthemes for "teacher role" are manager, learner, facilitator, and guide.

Theme-based exploration. This feature of KANE teaches the student that concepts are irregularly applied in complex domains. When a user requests a theme-search from KANE, the program provides a visual essay. Through this guided presentation, the nature of concepts are shown in their actual occurrence rather than told. The user can draw commonalities about the concept through theme-based exploration, but more importantly, he/she can acknowledge the variability in conceptual use. In LEAP, pre-service teachers can choose to view mini-cases exploring one particular theme, such as student role. They can also choose to view the mini-cases pertaining to one teacher in the order of occurrence in her class.

Expert Commentaries. In KANE, the commentaries that were written by experts provide assistance for (a) recognizing how the scene substantiates the theme, or tailoring the theme to the scene; (b) accessing features of the scene that can be linked to the theme; (c) relating the theme to other themes in the same scene, or emphasizing multiple perspectives; and (d) relating current instances to other instances of the same theme in other scenes. The commentaries from reading/writing workshop experts in LEAP work in the same manner.

Theme-combination-based exploration. Traditionally, knowledge has been compartmentalized; that is, broken down into abstracted general concepts (Spiro & Jehng, 1990). Cognitive Flexibility Theory, by contrast, emphasizes conceptual combination. By acknowledging the validity of thematic perspectives in each mini-case, students learn that knowledge is affected by pattern interactions and context dependencies.

In LEAP this awareness can also be documented in various ways. Pre-service teachers or their professor can compose a video-supported document by linking segments of the laserdisc to icons that are embedded in their text. They can, for example, write a comparative analysis and include video slices of mini-cases or entire mini-cases in their writing to support their observations or conclusions. They can also prepare computer-screen transparencies in which icons linked to segments of the laserdisc are placed within outlined information which is projected using a liquid crystal display panel. Video representations can be accessed at pre-decided points in an oral presentation and played on a large TV monitor. Also, LEAP provides a Review menu option—an opportunity for the student to view teacher-selected mini-cases and write, on the computer, a response to a question posed by the teacher.

Planning

Four general planning strategies were used for the development of LEAP: identifying specific goals, identifying the contents of the laserdisc, formulating the software, and conducting small-scale feasibility testing.

The Goals

The goals were generated in collaboration with content experts at the University of Houston and Houston Baptist University. They are (a) to provide thematic "paths" for exploration by which the whole class, small groups, or individuals can traverse the video-cases of experienced language arts teachers; (b) to facilitate preservice teachers as they draw from models described in text and from examination of actual teachers in the formulating of concepts about literacy education; and (c) to provide a context, a shared experience, for discourse which could generate contextualized impressions and help identify assumptions of the reading/writing workshop in specific and the teaching of literacy in general.

Contents of the Laserdisc

Over 22 hours of classroom video was taped using two Panasonic "prosumer" videocameras. To decide what should be video-taped and how the taping would be done, consultants with experience in the field were brought to Houston. They included Dr. Ron Abate of the Videodisc Project Team at Cleveland State University where several video-case based laserdisc products have been created for teacher educators (see Benghiat & Abate, 1994). The Cognition and Technology Group at Vanderbilt University has also ambitiously developed videodisc programs in their efforts to redesign teacher education (see Improving undergraduate teacher education). Jan Altman, a member of their development team, conducted a workshop at the University of Houston on techniques of video-taping in a classroom.

Administrators at a large Houston school district provided names of four middle school teachers who use the reading/writing workshop approach. Meetings with the four teachers, each of whom had ten or more years of experience, provided information about how the reading/writing workshop is practiced. Three of the teachers agreed to be video-taped. A sixth grade resource class, an eighth grade mixed-ability language arts class, and an eighth grade language arts class with a high number of at-risk students were videotaped. The taping occurred within 2-4 consecutive days. Twenty-two hours of tape were recorded.

The Software Program

Plans for the software that would allow students to navigate through the laserdisc were finalized. Originally, the plan called for using Authorware Professional to create the software. However, Authorware did not effectively support some formats of information display, such as scrollable text fields that could pop up on the screen and contain clickable icons linked to the videodisc. Late in the development cycle, Authorware was replaced with HyperCard in part because theprogrammers involved in the project were most familiar with it. The LEAP software has five major options in its main menu:

1. *Teacher Stories* - Students view all the mini-cases for one teacher in chronological order.
2. *Themes* - Students are guided through a thematic arrangement of mini-cases.
3. *Creations* - Students write a video-supported document or create video-supported computer transparencies for a presentation.
4. *Re-View* - Students respond to a video-supported teacher-prepared question.
5. *References* - Students see a listing of useful books and journal articles on the reading/writing workshop approach.

Small-Scale Testing

Potential users of LEAP were identified as English/ language arts methods class students who are being prepared to teach in the upper elementary or secondary school levels. Eighteen students enrolled in a secondary English methods class at the University of Houston viewed randomly selected pieces of the video taken at two middle schools. Their discussion was video-taped and the transcript of their conversation was analyzed to identify the issues about the reading/writing approach that were generated as the tapes were viewed. Experts at Houston Baptist University, including the professor who would be using the LEAP prototype, also viewed random pieces of the tapes and brainstormed the practical applications of the program. They suggested that a reading/writing workshop collection of books accompany the laserdisc and software. Some twenty books written by proponents of the workshop approach such as Donald Graves, Lucy Calkins, Nancy Atwell, Linda Rief, and Tom Romano were acquired.

Developing the Prototype

Selecting Mini-Cases

The 22 hours of video-tape were edited and reduced to almost two hours of mini-cases—42 mini-cases. The mini-cases ranged in length from 35 seconds to 7 minutes. Copies of the video-tape containing the 42 mini-cases and an evaluation form were distributed to five experts on the reading/writing workshop approach. They determined which mini-cases illustrated the teacher role, which illustrated the student role, which best displayed the environment, and which were the most stimulating in terms of generating discussion.

Data from the mini-case evaluation form was used to determine which of the 42 mini-cases would be selected to store on the 30 minutes of space available on one side of a CAV laserdisc.

Preliminary Field Testing

The prototype is currently being used in a children's literature class at Houston Baptist University. Ethnographic techniques are being used to gather data for evaluating LEAP; the investigator has taken the role of participant observer. Classroom interactions are being video-taped and field notes are being taken; text files stored in computer memory through LEAP are also being gathered. This data will be analyzed using coding schemes to identify thematic domains.

Summary

Although all the data on LEAP has not been analyzed, the feedback from experts, including teacher educators, and feedback from preservice teacher eduction students indicates this type of material is a powerful way of involving students in the exploration of complex, somtimes "fuzzy" approaches to teaching.

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Using Laserdisc Technology in Elementary Mathematics Education

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The gap between theory and reality is a traditional problems in pre-service teacher education. Models of teaching presented in class are not always observed in school settings, and there is difficulty in making the connection between research about instruction and the real world of teaching. Videotape presentations of expert teachers help to bridge this gap but do not lend themselves to careful analysis of specific teaching episodes and strategies. Interactive videodisc technology provides the needed flexibility for this kind of pre-service teacher education (Goldman & Barron, 1990).

Introduction

The *Professional standards for teaching mathematics* produced by the National Council of Teachers of Mathematics (1991) is a rich source of information regarding the teaching of mathematics. Mathematics methods courses which prepare teachers to implement these standards are needed to improve mathematics instruction. The purpose of this project is to contribute toward this improvement by combining interactive videodisc technology and elementary mathematics education. The interactive videodisc produced by this project is designed to contribute to pre-service teachers' ability to present worthwhile mathematical tasks to students at a variety of grade levels.

Method

This project is part of a National Science Foundation grant to the University of South Alabama entitled "Validating the Use of Hypermedia in Elementary Mathematics Education." After initial investigation of the use of interactive laser disc technology, four institutions were selected to develop laser discs for use in elementary mathematics methods courses. The disc described in this paper focuses on worthwhile mathematical tasks and places emphasis on the quality of mathematical discourse taking place in the classroom.

After determining that worthwhile mathematical tasks, as presented in the NCTM *Standards*, would be the focus of the project, we identified expert teachers in the area using recommendations of principals and university intern supervisors. We conferred with these teachers regarding the NCTM *Standards*. Instead of identifying specific content and asking them to produce activities which exemplified this content, we asked them to tell us about an activity which they would use in the normal course of instruction which met the standard for worthwhile mathematical practice. We believed that by having teachers select the activity, the lessons would appear more natural and less "staged" for the benefit of the project. We also believed that the teachers would be more comfortable with a lesson of their own choosing. Basic mechanics of videotaping were discussed, release forms were distributed for both teachers and students, and taping schedules were established.

Results

The resulting videodisc presents two different lessons: a first grade teacher guiding children in the construction of manipulative materials and the use of these materials in understanding place value, and a fourth grade teacher integrating literature with mathematics and guiding children in the development of their own method to solve a multistep problem. The Hypercard stack that accompanies the laserdisc consists of three separate sections. Section one describes the NCTM standards associated with worthwhile mathematical tasks and provides examples of appropriate and inappropriate tasks. Section two presents the first grade lesson, consisting of a video card that allows for a variety of ways to play back the video and displaying the teacher's lesson plan. Section three presents the fourth grade lesson and is similar in format to the first grade lesson.

Discussion

Several conclusions can be drawn about the use of laser disc technology at this early stage of development. First, the ease of viewing parts of the lesson in any order, of reviewing essential elements of the lesson and skipping others, and of moving from background material to the lesson without the delays give laser disc technology more accessibility over video tape technology. Second, seeing expert instructors in real life, interactive settings is an assuring promise to future teachers of sources of assistance. These teachers lend a credibility to methods courses by allowing students to see the application of theories presented in class with real teachers and children who ask questions, have difficulty, and eventually develop mathematical understanding. We found that having teachers select and develop their own lessons, as contrasted with a series of staged episodes, produced a rich store of classroom incidents which provide a valuable bridge between the demonstration lessons in methods courses and the real world of the elementary school classroom (Martin & Riley, 1994).

In the technical preparation of the disc, important lessons were learned. Three classes were videotaped, although only two appear on the disc. It was very difficult to edit three hours of videotape into the 30 minute capacity of each disc. There is sufficient video remaining from the editing process for at least one and perhaps two additional discs. Editing of the videotape was time-consuming but crucial. A professional editor might have been able to accomplish the task more quickly, but might not have the expertise to include and omit the appropriate video sequences. At this stage, as well as in the taping itself, we believe that it is important that a mathematics educator collaborate with the technical experts. This assures that the content of the disc will meet the needs of the teacher education program component. It is not essential to write the Hypercard stack prior to the completion of the disc. In fact, we found it beneficial to have the disc completed before spending much time on the stack.

We have only begun to research more precisely the effects of these kinds of presentations on the development of ideas about teaching in our students. We are also interested in establishing a library of laser discs for all subject areas, especially at the secondary level, where all too often methods courses are not subject-specific. The technology holds promise for bringing future high school teachers into more immediate contact with expert teachers in their fields.

Acknowledgement

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Designer Programs for Teacher Education Classrooms

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In many colleges of education throughout the country today, one is still likely to find faculty and staff who fall somewhere along a broad continuum of technological literacy—from those who are just barely able to run a word processor or set up a VCR to those who are adept and knowledgeable with every aspect of technology. Those educators labeled as technology proficient are sometimes set aside in sub departments, and, at times, never mix with other departments in colleges of education. More and more, however, serious calls are being made for technology to be present not only in public schools but also to be modeled in colleges of education. The criteria for the National Council for the Accreditation of Teacher Education (NCATE) is one such example. NCATE mandates require that observers see technology integrated into college of education instruction. The expectation is that preservice students will observe knowledgeable, competent college of education faculty and staff using the latest technology in the classroom. This will hopefully help preservice students to feel readily able, through observed examples, to follow suit in their own classrooms as they graduate and enter the teaching profession.

The problem is that not all college of education faculty and staffs (a) are competent in manipulating technology, (b) are knowledgeable about the latest in technology—a feat in itself to keep current, or (c) have the time to design programs even if interested. How then can faculty and staff in colleges of education move towards more integration of technology in their own classrooms?

Instructional Strategy

An attempt was made to answer this need through six hours of summer graduate work in conjunction with a small grant. The first three-hour course was an introduction to bar-coding, interactive videos, and other technology. Students were also exposed to authoring programs such as Hypercard that allows students to write their own "stack" programs and to repurpose videodiscs for new interactive programs. The second part of the summer was then spent with graduate students collaborating with a faculty or staff member to design a program that could be used during the following year's educational lectures and/or course work. For this, each graduate participant received payment for three hours of graduate credit plus a small stipend, while faculty or staff members received a program tailor-made and ready for his or her own purposes. Two programs of this nature will be discussed.

Examples of Designs

One example of collaboration was initiated for a beginning undergraduate teacher education course and resulted in two finished technology programs. The subject matter (basic teaching skills) that was the basis of this entire course called out for real and specific classroom examples rather than verbal description by a lecturer. Particular concern for real examples lay in the area of teacher evaluation/assessment. It is often very difficult for students to understand how specific behaviors required for assessment can easily be incorporated into their daily lesson routines. It

○ More information on CD-ROM

is possible for instructors to script, then act out scenarios for demonstration in the college classroom, but it is never as effective as seeing real teachers in action coupled with reactions of their students. Neither is it very effective in large classroom to discuss situations seen by preservice teachers in observation situations. These descriptions often lack details needed for analysis and time is limited, so the many varied examples students bring to class cannot be discussed in sufficient depth. A second concern for this course was time allotted for assessment discussion. So many critical issues are covered in this course that teacher assessment is allotted only one lecture/participation period. Yet, students go from this course into student teaching where they are expected to know and perform effective teaching behaviors listed on the university assessment instrument (which duplicates the state appraisal instrument). In addition, first year teachers are judged by many districts on the behaviors listed and discussed in this course. How, then, could specific required behaviors be made to be seen as realistically doable for teachers-to-be, and how could instructors encourage student retention for both the desired (and often required) teaching behaviors discussed in class and student reactions to those behaviors? Finally, was there a way to show value for these behaviors to preservice teachers?

Bar-Code Lecture

The answer was found in technology. The first program designed for the purposes discussed above was a bar-code lecture. Many examples of this exist, particularly in the newer science curricula. For education, a program designer reviews previously filmed videodiscs of entire class periods or discs already filmed and designated for other purposes (of which there are a number of commercial programs). These program designer then selects sections to demonstrate exact behaviors needed for discussion within the context of a lecture. By using an authoring program to number definite frames where one wishes to begin and end, specific scenes can then be isolated for easily playback. These short scenes can be played and replayed quickly using a bar-code scanner as many times as needed to have preservice education students understand the concept. For example, the class may first be directed to concentrate on the teacher, then watch the reaction of students in a replay, and so forth. For this project, scene clips were selected and used in class to answer preservice questions regarding exactly what an assessor might looks for in teacher behaviors when marking teacher use of routines, monitoring, closure, and all other teacher behaviors listed on the assessment instrument.

MacAssessor

The second part of the dilemma in this course was more difficult—that is how could presentation of information be made more meaningful, so that preservice students could remember teacher behaviors and student reactions? Moreover, Texas colleges of education are required by the state to have preservice students in field observation situations for a number of hours. What type of instructional tool might offer an additional mechanism to help students enter those observation placements in a more analytical and critical manner, and thus hopefully aiding the education student in gaining more from experiences in real classrooms? The answer here seemed to be in interactive video programs, as time for more discussion of this topic during class was extremely limited. Interactive sessions, however, could be done outside of the classroom for reinforcement and for introducing some supplemental information. In addition, individuals or small groups could use the session at anytime, particularly before beginning student teaching as a reminder of what behaviors were to be assessed by the college of education and later their district. This could be accomplished without an instructor.

MacAssessor was designed as an interactive video instructional program (IVI) specifically for preservice teachers to aid in critical thought regarding appraisal. It simulates placing a preservice teacher in the role of an appraiser—the preservice teacher is asked to "aid a principal" in assessment observations. This "game" allows the preservice student to become more familiar with the teaching behaviors stipulated by the university student teacher appraisal instrument as well as that of the state. It also offers the student a new perspective—a look from the assessor's eyes. Its creation supports Berry's (1994) statement that "interactive video makes it possible to increase the amount of active stimulation teachers can experience while providing for great control over the nature of that experience" (p. 82).

Much research has been done on thought processes that allow computer programs to teach well. Consideration of these processes was made in the design process of this program as well. Programs developed for all collaborative instructional programs were not simply thrown together, but such concepts as development of schema, perception, motivation, reinforcement, and so forth were joined on a daily basis within the framework of the technology during development.

Doyle (1976) and others who have researched expert/novice literature note that as experiences become more consistent and more predictable, information can be processed with fewer task-oriented categories. Experienced teachers work from schemas developed from their past. Once formulated, a schema enables a teacher to quickly recognize and interpret events, predict possible states, then direct activity more easily. A knowledgeable teacher can, therefore, manage a classroom with a minimum of information cues. Formation of schemas is of concern to teacher educators because of the need for novices to develop them. This ties with the problem discussed above—that is, how is an instructor to explain schemas when a class is unable to see the same teaching behaviors and student behaviors for discussion. One way to help, however, is programs such as this that allows demonstration of isolated behaviors in the complexities of teaching within the context of the whole. Hopefully, preservice teachers are able to then translate isolated incidents more easily into routines because of another important area in research on thinking—that is, "seeing is believing you can do it" (modeling in social learning theory). Often after an instructor introduces the evaluation instrument with its lists of multiple teaching behaviors required to be seen in a 45-minute lesson cycle, the reaction of preservice teachers is, "No way—I can't even remember a fourth of those behaviors, much less do them!" However, this program allows students to see real teachers (multiple times if necessary) accomplishing these behaviors easily and effectively.

All educational learning theory courses include sections on perception—that is, being able to see something only when a picture is viewed from a different perspective. This area of thinking was seen as one of the most important in developing this particular program. It was hoped that by asking preservice teachers to change perspectives (to that of an assessor), that stepping into those shoes would help to give them the "ah ha" experience or, "Oh, *that's* what a principal or an evaluator means when they say a teacher doesn't monitor. Look at the students! They really aren't getting anything out of this lesson! I can see that so clearly now!" Preservice teachers placed in early field experiences sometimes become susceptible to grumbling comments made by their teachers about many of the behaviors listed for appraisal. Although authentic teacher assessment should certainly be looking at other areas of teaching besides lists of behaviors required to be performed in each lesson, it is important for preservice teachers to see what happens in classrooms when many of these research effective teaching behaviors are present or absent. This critical perspective can often make a difference in their own reflective teaching practice.

Motivation was another area of concern. Nowicki and Strickland (1973) noted that children are motivated in schools when they can attribute success or failure to their own efforts, rather than factors over which they have no control—that motivation happens when they are the controllers rather than the controlled. This control factor correlated more highly than did IQ with success in school. MacAssessor was set up to allow preservice students to feel almost completely in charge—that is they may move to see a video again and they may check to see again why their thinking was or was not the same as an assessor. This program was also designed to let students work at their own pace, ask for help, and to stop completely and come back later or another day if they so desire—the player controls the pacing of the information. This helps to lessen anxiety associated with "getting the right answer quickly" and the anxiety associated not being skilled with computers.

Many of the videodiscs selections were chosen for good teaching ideas which students would, after viewing, be able to take into their own teaching. Thus, concern for relating to the "world of the learner" was another design factor. The negative examples were clear as well; for it was believed to be motivational for preservice teachers to be able to say, "Look at that! I already know better than that!" The self-efficacy aspect of video watching has been seen by several researchers to be an important area of thought that helps the learner (Salomon, 1984; Cronin & Cronin, 1992). Teaching in all levels of public schools was included so that preservice students preparing for elementary, middle, or high school would have teaching situations in which to relate.

Another point in design involves stimulus/response. The student is rewarded or punished with a "game show-like" audio reinforcement. If the student selects the correct answer, the computer rewards them a small "Wheels on the Bus" melody, and if the wrong answer is selected, another sound indicating failure is heard. The feedback loop was designed not to let the player out if the student answer was incorrect. The student is unable to move on to the next scene until he or she reads feedback for the incorrect answer chosen. For example, if the student answers all questions in a series but number three correctly, then signals to go to the next card, a balloon will appear that states, "You did not complete question three correctly. Please have another look." Then, the player must select the correct answer and see the appropriate correct response message. This is considered of importance in discussing assessment, as confusion over desired behaviors can be eliminated easily through feedback.

Attention is another factor in learning considered in program development. The clips were selected first to work from simple to complex—that is, beginning clips asked the student to watch shorter and more simplistic behaviors, then move into viewing and evaluating longer and more complex series of behaviors. Second, selections were to offer as clear examples as possible of the behavior that instructors wished them to see. The reinforcement comments were designed to be at a collegial level rather than a profound, literate level to maintain focus. Sometimes, they are designed to be humorous to keep attention and to keep the student moving through the program. This idea of interactivity coincides with Levin (1983), as he notes that these types of programs are the best of both worlds. They have overtaken the passive learning which TV alone provides in education and the boredom that the computer alone sits up with only the information with its immediate feed back. They offer both fun and feedback.

Discussion

An overall look at the designer programs and the results of the collaboration revealed several areas of interest for discussion. Several problems with repurposing did emerge. However, the gains to faculty, staff, and graduate students were very positive in nature, as were the benefits offered to preservice students.

Problems in Repurposing

One concern noted in creating designer educational programs was the choice of materials. As of this time, the choice of videodiscs is still so small that no one disc seems to offer everything an instructor may need for students to see. Filming one's own disc is extremely involved. [See the paper by Stephens in this section for a description of the process involved in creating a computer-controlled videodisc from classroom video shot specifically for that purpose.] This may mean that those involved in lectures and/or students using the programs such as *MacAssessor* must exchange discs several times during the course of a program or lecture. Interrupting the flow of instruction is just one of the disadvantages this limitation brings.

Shortages of good materials may also affect the process of designing a program. Design problems occur when a choice must be made to either have a sequenced order of events or have a distracting amount of disc switching occur.

Other problems need to be considered regarding videodiscs for these repurposing programs. The cost of numerous copies of videodiscs is also still relatively expensive. This leads to the problem of not having enough discs to set up multiple computer stations, if needed. Repurposing capabilities may also mean that others in the college of education are using the same discs for their own programs. Thus, the discs do not tend to remain in one location long enough to allow a long scheduling period, or they must be chased down if needed for lectures.

Finally, there is a considerable physical effort to get programs set up for class or station usage. Computers, monitors, and videodisc players must often be located and transported to new areas, and setting up technological equipment can often be a stressful experience.

Benefits for Graduate Students, Faculty, and Staff

Many positive outcomes were seen in this course for graduate students, faculty and staff. Six hours of graduate credit provided graduate students with the knowledge and skill needed to develop these types of programs for any setting into which they may go. The required collaboration was also a good basis for learning more from faculty members about their subject matter and methods of instruction.

Foremost, faculty and staff members are provided with immediate access to new technology for their course(s) that was tailor-made for their use. Though interactive programs exist, they often do not match particular ideas or time frame in instruction. This type of collaborative design answers sighs often heard by instructors when technology is discussed such as, "This is great, if only it fit my own personal needs a little more." Faculty and staff members are not only provided with technology fairly easy to use for their course and for their own teaching style, but the collaboration and the use of the programs may also spark the motivation to learn more about technology after having been involved in its conception and having seen its results. When educational hours are limited, the interactive design provides a way for instructors to have students access additional information or reinforce what is taught when there is no time in regularly scheduled course hours. Finally, colleges of education can be provided with a technological library base of programs usable for all members of the faculty and staff.

Advantages for Preservice Teachers

It is believed that the education students for which these programs were designed are the true beneficiaries. The preservice student is provided with real-life examples of ideas and concepts which teacher educators are attempting to have them understand. The student is offered the opportunity to see concepts isolated for discussion in a lecture room or on their own and in a way in which scenarios can be repeated as many times as needed so that concepts can be reinforced or corrected immediately. Many more examples of classroom experiences are shown to students, rather than hearing about "when I was teaching..." from instructors. Preservice students are seeing technology in use, and they are being able to use it directly in interactive programs such as *MacAssessor*. This is extremely important since many preservice students are applying for teaching as older adults who are not coming out of computer literate high school programs. Preservice teachers are also being asked to work at higher levels of thinking by using evaluative skills.

Wonderful programs of interactive videos exist at very expensive prices for law schools and for training in various mechanical and medical areas, but tailoring many of these ideas to one's own educational classroom is truly available now. In addition, establishing ways such as the six-hour collaborative effort discussed here in which graduate students are utilized for designers can be of high value to graduate students, to faculty and staff in instruction, and certainly to the preservice teacher.

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MacAssessor has been furnish for the CD-ROM Edition of the Annual. Unfortunately, all repurposed discs could not be included, but are listed in the preface.

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Incorporating Technology into a Program for Three and Four Year Old Boys and Girls

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Educators presently have more questions than answers concerning the role of technology in the curriculum for 3 and 4 year old children. For example:

1. Since the availability of electronic games, toys, and computers in the home varies according to family income, does this affect the child's use of these devices in the school environment?
2. Do children whose parents use computers in their work choose to use the computers at school more than children whose parents do not use the computer?
3. What is the role of computers and other electronic learning tools in the early childhood curriculum?

The purpose of a study at Henderson State University was to answer the above questions by gathering observational data in the school setting and survey data from the home. Information was also gathered from other studies and opinions of experts.

Design of Study

Henderson State University has operated a half-day program for thirty-six 3 and 4 year old children. A second half-day program for twenty "at risk" 3 and 4 year old boys and girls was initiated in 1991. These fifty-six children were approximately grouped in half according to gender and to regular or at risk children. Minority representation among both groups was about equal.

Observational data were gathered from the 3 and 4 year old groups in both the morning and afternoon sessions. In order to assure consistency, the observational data was gathered only during the daily 30 minute free play period for each group, over a ten day period. The observations focused on the number of students electing to use computers during free play and the number of minutes each student remained at the computer. Those students electing to go to the computer stations were counted as using the computer even though they may have only observed.

A telephone survey of early childhood coordinators, in the fifteen educational cooperatives, was conducted to ascertain the availability of computers for use in the classrooms by the children, ages 3 to 5, who have been identified as having disabilities.

Results of Parent Survey

The parents or guardians of children, ages 3, 4 or 5 years, enrolled in preschool programs were asked to complete a survey about technology. Three types of programs — at-risk, regular, and Headstart — were involved in the survey. A total of 122 forms were returned. The survey contained six questions; four questions related to the family accessibility of computers or electronic games, and two questions requested the listing of programs or electronic games used by the young child.

Of the 122 forms returned, 35 percent (N=43) of the parents used a computer in his/her work. This indicates that the majority of the parents, 65 percent (N=79), did not utilize a computer in their employment. (See Table 1.)

The number of homes which had computers was 15.6 percent (N=19), and 84.4 percent (N=103) did not own a computer. However, when asked if the parents favored the use of a computer as a teaching tool in the classroom, 84.4 percent (N=103) responded positively, 14 percent (N=17) indicated they did not favor classroom usage, and 1.6 percent (N=2) had no response.

Thirty-nine percent (N=48) of the respondents possessed a Nintendo, a video game machine, with the Mario software listed most frequently as the favorite game.

Frequent comments related to Nintendo were: "He plays with it all the time," and "She plays this game very well." Other comments of interest were "Children enjoy the independence; learning by themselves gives them pride," and "I would recommend computers in every school as a teaching aid."

Table 1

Computer Accessibility by Children Percentages

Item	Yes	No	NR
Computer used in parent's work	35	65	
Computer in the home	15.6	84.4	
Parents favor computer as teaching tool	84.4	14	1.6

Results of Classroom Observations

The primary purpose of the observational portion of this study was to ascertain how many times children enrolled in programs at the Child Service Center selected computer activities as their free play choice and to determine an approximate duration of each of these interactions. The three and four year old students, enrolled in the regular morning program as well as those in the special at-risk afternoon class, were subjects for the study. Summary information is shown in Table 2.

Table 2

Duration of Technology Interactions

	# Students selecting computer as free play	1 min.	1-3 min.	4-5 min.	5-+ min.
Regular	136	30 (22%)	24 (18%)	33 (24%)	49 (36%)
ABC	144	27 (19%)	24 (17%)	25 (17%)	68 (47%)
TOTAL	280	57 (20%)	48 (17%)	58 (21%)	117 (42%)

The number of times when the computer was selected for free play is comparable between the two groups. The breakdown of the durations reflects some differences; however, it should be noted that 42 percent of all interactions were more than five minutes in duration. Multiple factors account for individual differences in learners, including motivation, interest, and developmental levels. Decisions about developmentally appropriate activities for children should be carefully made and must include consideration for individual differences.

Additional data were recorded on those students who maintained computer interaction for more than five minutes. Students' names were recorded and their parental survey forms were cross-checked to determine availability of computers in the home. Of the 49 such interactions (36 percent) from the regular students, 26 had computers in the home. From the 68 interactions in the at-risk group, none reported computers at home. Although these observations might suggest that the novelty of technology could be a motivating factor in its selection, the responses of the regular students indicate that technology offers other motivating factors as well.

One of the concerns generated, relative to usage of computers with young children, focuses on the need for verbal interactions in language development. Observers in this study were asked to record the number of students who maintained longer than five minutes of interaction and were voluntarily verbal during the interaction. Of the 117 instances, 75 (64 percent) involved such activity. It should be noted that no attempt was made by the teachers or observers to prompt verbalization, nor was software selection based on fostering language interaction.

Computer Use in Other Centers

There are 15 educational cooperatives distributed throughout the state. In each cooperative, an early childhood special education program is directed by one coordinator who services more than one public school district. In the telephone survey, 12 of the 15 coordinators responded; three were unavailable on two repeated contacts.

Eight coordinators indicated that computers were accessible to the children, ages 3 to 5. Four coordinators indicated that they did not have computers available for use by the children, although one of the four indicated that last year the contracted speech pathologist did use computers with her clients. Also, one coordinator stated that the purchase of computers for their programs had been requested.

The type of computers in use were evenly divided between the IBM/Compatibles and the Apple family. One coordinator indicated that she had a MacIntosh for use; another coordinator stated that when funds become available, a change will be made from the Macintosh to the IBM compatible.

A total of 532 children in this survey have access to a computer with most programs reporting both free choice and structured (planned) activities utilized. A common response was that the computer was one center which could be used in either a structured or free choice activity. One program has a touch screen available.

A request was made to list the five software programs used most often. A variety of names was listed with the Sticky Bear programs, such as *The Alphabet* and *The Opposites*, and *Katie's Farm* being listed most frequently. Other software programs listed were:

Millie's Math House
McGee at the Fun Fair
Ollie Octopus Sketch Pad
Bailey's Book House
Marvin, the Moose
Creature Features

Math and Me
Berenstein Bears, Colors and Letters
Playroom
Mickey 1-2-3
Mickey's Combo Pack
Donald's Alphabet
Talking Nouns and Verbs
Early Games 2 1/2 to 6
Kid Pix
Shareware from *I CAN* located at Easter Seal

All coordinators noted that the children seemed to enjoy interacting with the computer. Two coordinators emphasized the positive impact of computer use with children who have autism.

Recommendations

Useful information and tips on how to effectively use computers in the early childhood classroom may be obtained from the reports of others, but much is also learned from firsthand experience. The key is to be courageous enough to try the untried. Technology offers additional learning opportunities for young children. Among the advantages of using technology are that it provides:

- a supplemental teaching aid that encourages thinking and exploring,
- an increasing supply of age-appropriate and developmentally appropriate materials that include emergent literacy concepts and counting/numeral experiences,
- a motivational learning medium that encourages completion of tasks through game-like activities, and
- another option for individualizing instruction with varied levels from which to choose resulting in promotion of positive self images in learners.

There are some cautions relative to the use of computers in the curriculum for young children. Some of the concerns may include the following:

1. inferior or inappropriate software,
2. regular keyboard is too small for young children,
3. attention span of young children results in incomplete activities,
4. limited opportunities due to costs, and
5. teacher supervision/directions required by some programs.

Careful selection of computer software programs is necessary in developing this resource. Beaty (1992) recommends that the best software for preschoolers should contain:

1. nonverbal directions
2. ease of operation by children
3. control by children
4. high-resolution graphics, sound, and animation
5. content that can be integrated into the curriculum

Conclusion

The concern about educational equity among children in our early childhood programs, especially those boys and girls who may be identified as "at risk," appears to be valid. Parents and/or guardians who have average or better incomes are able to afford electronic toys, games, and computers for their children's use. Children's acceptance of computers and their casual approach to them, reinforce the belief that the computer and related technologies belong in the classrooms for young children. Those who develop the curriculum and guide the day-to-day classroom activities for young children are responsible for assuring a proper balance between the use of computers and other learning tools.

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Technology and Young Children: What Teachers Need To Know

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The purpose of this paper is to discuss what comprises an appropriate use of computers in the early childhood curriculum and how the teacher may implement that curriculum. Included in the discussion are the educational tasks which young children are capable of accomplishing with the computer. Preservice and inservice teachers are experiencing encouragement and even pressure to use computer technology to enhance instruction. In a 1991-92 statement of requirements The Association of Childhood Education International (ACEI) inserted as one of their teacher preparation requirements that preservice elementary teachers display "an understanding of and skill in using technology and media." The ACEI further reiterates its position by stating that teachers should be allowed to critically select and use appropriate resources, materials and technology in the pursuit of education.

Rationale for the Discussion

Many teachers and technologists who work within the school environment may have low expectations of young children and technology that stem not from an objective assessment of the student and the task, but more from a myth that the more advanced the technology, the more intellectual development is required (Shade, 1988). Most early childhood educators have overcome this myth with the advancement of reliable software, something not available with the introduction of computers in the late '70's and early '80's. Another barrier to the productive use of computers was the non-reading, non-typing children at a time when computer responses required reading from the screen and facility with the keyboard. That too, has been overcome with skill-specific software. Young children have much to gain from the use of technology. It is important for technologists and teachers of young children to be aware that young children are competent computer users (Shade, 1988).

As early as 1985, Clements began to suggest that "even among preschoolers, the microcomputer may challenge and alter traditional instructional modes" (p.3). Later studies have continued to confirm that technology has much to offer aside from early drill and practice applications of the 1980s (Clements, Nastasi, Swaminathan, 1992). Finding ways to accommodate young children's capabilities may challenge and alter traditional instructional methods. As technology continues to develop a friendlier interface, it becomes both appropriate and necessary to look at the ways in which young children may be encouraged and facilitated in its use.

Who Are The Learners?

Early childhood educators often refer to their specific group of learners as the age group from birth through eight years. Including non-readers as potential learners is appropriate and necessary for the discussion of early childhood computer users. Two research teams, Shade and Watson (1987) and Brinkley and Watson (1986, as cited by Shade) recommend that the age of three should be selected as an appropriate time for introducing children to the computer, with the caveat that appropriate "discovery-based" software be used.

Some researchers have concluded that computers do not belong in the early childhood setting (Schwartz, 1985). Most researchers, however, have since refuted the idea that computer use has detrimental effects on young students. Paris and Morris (1985) reported that children 4 through 7 years old were able to take instruction, follow verbal directions, and successfully peer teach-help in conjunction with computer projects. Perlmutter (1985) found that children who worked with a peer showed a more positive affect and retained more experiences than those who worked by themselves.

What is the Optimum Curriculum?

Researchers (Shade, 1988; Swick, 1989; Char, 1993) agree that there are three essential components of a successful computer curriculum in the early childhood environment. These components are:

1. an appropriate location for computers *in the classroom*
2. teacher knowledge of the program and expertise with the computer
3. interactive or discovery based software

Arranging the Classroom

There is disagreement whether the computers should be housed in a laboratory or maintained as part of each classroom. Solomon (1990) stated that one erroneous assumption "is that the computer is an entity in and of itself and thus deserves a special 'laboratory,' a special curriculum, and a special teacher to teach it" (p. 51). Maddux (1991) indicated that such a rigid assertion cannot be made. "Labs are necessary because there are not enough programs or hardware to accommodate classrooms and teachers are not computer-literate enough to permit thoughtful, beneficial computer integration aimed at achieving important educational goals" model for the children (Swick, 1989). Teachers who display their own comfort and expertise with technology in the classroom may make the first and most important impression on young children, particularl if they do not have a computer in their homes.

The classroom teacher must not underestimate the capabilities of the young child when using computer technology. Children are able to select, classify, distinguish, compare, create, and problem solve. Given the recording features of multimedia computers, children are also able to "write" successfully. Children may create art work or play interactive games on the computer. Swick (1989) describes several other experiences available to children interacting with computers and appropriate software, learning to use fine motor skills, making meaningful play, and developing social skills and developing language if given the freedom to explore words, meanings, and combinations of these.

Teaching Classroom Teachers About Technology

Various methods have been suggested to teach preservice and inservice teachers how to use technology successfully within an instructional setting (Cashman and McCraw, 1992). Nothing, however, in our view, can take the place of on-going interest and hands-on experimentation *by the teacher* with the computer and available software.

Appropriate Software

Developmentally appropriate software is crucial if young children are to successfully use computers (Shade, 1988). Researchers recommended that special software must be developed for early childhood situations and that such software should be based on a knowledge *of how children learn* (Shade, 1987) There are several key points upon which most researchers agree:

1. Children learn by experiencing and therefore need to be interactive with the computer (Char, 1993, Shade, 1987, Swick, 1989).
2. Learning should be open-ended, which means learners benefit from discovering rather than being told (Branford, 1989 cited by Hannafin, 1994).
3. Children as young as three years old are capable of manipulating "microworlds" (ie. Microworld, Beachworld, LOGO for early childhood) (Shade, 1987).
4. Appropriate software should help children reflect on what they already know (Baumberger, 1983, cite by Char 1993; Haugland and Shade, 1988).

Many of the recommendations for software that researchers made in the those early years between 1977 and 1985, were not followed. In 1988 Dr. Daniel Shade developed his own software, *Microworlds,* and began to report on the progress of young children with what he called "discovery-based" learning. Current research calls this kind of software "student-centered learning" (Hannifan, Hall, Land, Hill, 1994). Their study indicates that such software allows students to "establish and mediate important issues." Seymour Papert, an educational theorist, was instrumental in the development of LOGO and was one of the first educators to note the value of a computer program controlled by the child (Papert, 1980).

Translating Theory Into Action: A Case Study

The authors, education faculty in a small state university, participated in a partnership between a local elementary school and a university. The elementary school, with grades K-5, has approximately 500 students and 30 teachers, 8 of whom volunteered to take part in a project. Seventeen university students and 4 university faculty were involved in the project which included university courses: Developmental Reading, Children's Literature, Multicultural Awareness, and Technology Integration. The project incorporated thematic units using topics chosen by the children the previous semester. University students, classroom teachers, and children developed integrated units.

One of the components was to incorporate technology into the teaching of the thematic units using the platform of the Macintosh Quadra, a multimedia computer, and HyperStudio software. Pedagogical and technological challenges were posed for project participants. Some of the challenges were met and overcome, others were unresolved.

Technological Challenges

One of the difficulties encountered by the professor of the technology course was the incompatibility of platforms between the university and the public school. That problem was solved by teaching students in the media center at the elementary school. It also gave them a chance to use the zapshot camera and scanner, neither of which were available in the university classroom.

There were only three multimedia computers in the elementary school which had the capabilities for using HyperStudio. Most students had to find time to come to the media center and work on their stacks. It was also difficult to bring children down to that small area so that they could be involved in the planning and input into the stack topics.

A final challenge was to train and motivate inexperienced teachers to use the computer technology effectively in their classrooms.

Pedagogical Challenges

The pedagogical challenge was to successfully use thematic instruction and integrate technology. To achieve those goals all participants would be expected to understand the components of an integrated unit and understand how to use the computer to enhance instruction. We have chosen to divide this part of the paper into three sections for clarification: our observations, findings, and recommendations for implementing a successful future program.

Observations. Depending on their understandings, individual classroom teachers reacted differently to the demands of the project. Classroom teachers could be classified into three general categories. Those who displayed:

1. an understanding of integrated units and technology
2. an understanding of only technology
3. limited understanding of either technology or integrated units.

While aware of both technology and integrated units, university students had no previous classroom teaching experience and could not be expected to teach these concepts to the classroom teachers.

Successes. To qualify as a success with the project we rated teachers as 1) employing a student-centered classroom and 2) using the computer with open-ended student centered activities. We observed *team-teachers* who seemed to be able to incorporate all of the components into a successful curriculum. We believe that their success was due to their own active interest in both integrated thematic instruction and use of technology, as well as unselfish hours of preparation and dedication in the interest of providing their students with a high-quality learning environment. University students began to appreciate the vast amount of time expended and thought given to a student-centered learning environment. It became apparent that workbook and textbook assignments were far less work than integrated units, which required extensive planning and gathering of teaching materials and resources. However, the units encouraged active student participation and opportunities to experience the benefits of computer technology. Children were given ample opportunity to experiment, explore with, and use the computer in the curriculum.

Partial Successes. The majority of participating classroom teachers were rated in this category. She or he did not fully understand the concept of student-centered learning or had limited understanding of technology, or a combination of both. When university students attempted to incorporate technology into classroom activities, the classroom teacher, unfamiliar with technology integration, displayed great discomfort with that teaching style. One student stated that "the classroom teacher wanted the students to be working quietly at their desks and was disturbed when a group worked excitedly at the computer."

Other partial successes included teachers who used the computer often themselves, but seldom allowed the children to do so. One of the university course requirements was to build a HyperStudio stack in which the children would be involved in selecting the topic and inputting information. What actually happened was that the classroom teacher and the university students cooperated in building the stack and then allowed the children to read it. Children were allowed to used the computer on a limited basis, usually with teacher-directed activities. In contrast, non-reading kindergartners were among those who were able to use the computer to record theme-related songs, observations, and information.

Failure. One teacher in our group seemed to have difficulty in providing any class activities which involved the computer. The computer was sitting in a separate room and used only with the teacher's direction. On one occasion when outside visitors were expected, she did make an effort to show that her children were incorporating the computer into the curriculum by allowing students to use the computer to produce some theme-related art work.

Findings. The most unique finding in this study was that *the use of the computer most often paralleled the individual teacher's instructional style*. When classroom teachers used direct instruction rather than discovery learning, they most likely used computer programs in the same way. When teachers were accustomed to teacher-directed instruction, they chose computer programs which were not open-ended, but contained specific teacher-chosen outcomes such as drill and practice, electronic worksheets or tutorial programs. In contrast, when teachers employed child-centered teaching methods, they were more likely to provide opportunities for their students to work with interactive software independently or cooperatively with peers.

In classrooms where university students attempted to use the computers interactively but in which the classroom teacher had little or no experience with either student-centered learning , technology or technology integration, we observed conflicting experiences. In student-centered classrooms, the teacher acted as a facilitator to students working with the computer to research information and complete projects of interest to them. The student-centered environments were messier, nosier, and thus more difficult for the traditional teacher. As the project progressed, classroom teachers with limited understanding of student-centered integrated units continued to teach in a subject specific manner and the computers were used little in their classrooms.

Recommendations. On reflection, we believe that all the participants in the project should have had an in-depth understanding of integrated units, student-centered learning, and more than a cursory understanding of the computer system and software with which they were working. Overall we believe the motivational factor in the student-centered classroom to be far more favorable to learning. In the classroom where participants understood the components of the project, we observed more learning taking place. In situations where children were not allowed to fully participate, less learning was observed. In classrooms where teachers did not understand and therefore did not take advantage of the benefits of computer technology, children were deprived of that aspect in learning.

We recommend that computers be placed in classrooms so that they are available for young children to choose as they would any other learning center. We believe that an in-depth understanding of the capabilities of the young child is imperative for the successful incorporation of technology into their curriculum. Low expectations of students were often the reason for employing a teacher-directed curriculum, rather than letting the children themselves take a more active role in designing instruction. University students displayed some of the same tendencies toward devaluing young children's capabilities. Those same students were most surprised to discover that when given the opportunity, very young children could accomplish many tasks using technology.

A final and crucial recommendation is that software specifically designed for young children be acquired. Specific software titles should be researched, tried before purchase and should include the attributes of interactivity and open-endedness. We also believe that inappropriate use of software, such as only drill and practice programs or only teacher-directed activities, should be abandoned, as those applications are of little value to young children and may even stunt their technological growth.

Conclusions

Believing student-centered learning and technology integration to be beneficial educational practices does not mean they are easily achieved. By objectively stating outcomes and then applying those outcomes to field-based experiences we had hoped to instill a sense of real-life expectations into our preservice teachers. By executing these applications in a dynamic school setting, we also hoped to also infuse into and share some of our goals, aspirations, and achievements with the working classroom teachers. Yet, to a degree we were unsuccessful in achieving those objectives. Part of the reason we were less successful is that we were working with a group of classroom teachers with whom we were unfamiliar. We were not fully aware of their commitment to the project or their understanding of the components. If we approach a similar project in the future, we will spend more time in the beginning with the classroom teachers to explain the concepts, paving the way for on-going coaching and consultation during the semester. It may also be beneficial to ensure their understanding of the role of our students as novices who are above the level of an observer, yet not a student teacher. Our students are able to achieve some of their teaching goals, but they still need constant encouragement and guidance from the classroom teacher. Those students in return bring enthusiasm, a sense of excitement about their future careers, and perhaps, some new ideas about teaching methods and the use of technology in the classroom.

We, the college faculty, have to help our preservice teachers recognize potential problems and their possible solutions. We have to help them accept the compromise that often takes place in the classroom in which partial success is achieved. We believe that most future teachers, given information and encouragement, will be able to succeed. Our own goals and aspirations are that our preservice teachers will develop a comfort level with technology, technology integration and excellent teaching methods. The promise for the future is that we, as educators, must continue to expect and demand effective classroom teaching and thus provide quality education for children at all levels.

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Using Technology to Provide Authentic Learning Experiences for Preservice Teachers

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Project KITES, Kids Interacting with Technology and Education Students, is a collaborative technology initiative designed to provide preservice teachers with models and practice for integrating into their teaching while providing them with realistic experiences for working with children. Beginning elementary education students were paired with fourth-graders to work on technology-based language arts projects. Project KITES provided these prospective teachers with opportunities to grow as educators. Through active participation in team projects, these students became advocates of a more interactive approach to teaching and learning. They came to value using technology as a tool for learning while becoming more comfortable with technology. The college students gained needed confidence about their abilities to work with elementary students and reaffirmed their decision to become teachers.

Introduction

To produce more technically literate teachers, educators in the College of Education and the University Lab School at Louisiana State University developed an initiative called Project KITES. This program provided preservice teachers with models and practice for integrating technology into their teaching practices through realistic experiences working with children.

The approach taken was to pair each beginning preservice teacher with one fourth grader to work on technology-based projects in the language arts area. Thus, both the prospective teachers and the children learned together. The expectations were that through these experiences, the pre-service teachers would naturally view technology as a normal part of their teaching environment and learn ways that technology could be used to enhance instruction. At the same time, they would develop skills to help them serve as facilitators and collaborators in learning that will be critical in the technology-rich classrooms they will enter. Finally, they would acquire confidence in their computing skills and teaching skills in the non-threatening, supportive environment in which they were working.

Data collected during the study and during post-project interviews indicate not only these goals were met, but also that there were dramatic changes in the perceptions of the pre-service teachers about the roles of teachers. Most of the education students emerged with strong feelings about their chosen profession and their abilities to cope with the challenges of teaching. Many gained increased appreciation for the use of technology in the classroom and expressed strong convictions about the role that technology should play in their pre-service training and their own future classrooms. Indications are that these changes are clearly linked to the real experiences and insights gained through participation in Project KITES.

Theoretical Perspective

In 1994, the National Council for the Accreditation of Teacher Education (NCATE) revised its unit guidelines to include indicators which reflect the infusion of technology throughout teacher education programs (Thomas, 1994). Currently, many colleges of education are modifying their programs to meet these new standards. Many programs have issued Internet accounts to students and have required them to communicate with professors and classmates and participate in electronic conferences (Bishop-Clark, 1993; Wiebe, 1993). Some colleges of education are focusing on faculty development while others have also implemented a technology-specific course (Hess, 1990).

Kerr (1991), however, found that a single computer course does not provide pre-service teachers with learning activities which demonstrate how technological applications can be used in specific teaching disciplines. Researchers (Novak and Berger, 1991; Jensen, 1992) suggest that it is unreasonable to expect novices to use computers or to integrate technology into teaching practices after taking a single computer course. To effectively use technology as a learning tool, Ehley (1992) recommends that present and future educators be trained in computer use and be able to draw upon effective models of computer integration. Project KITES was based on these philosophies.

Project KITES marked a distinct change in the approach to using technology in education classes at our university. Formerly, prospective teachers were required to take one introductory educational technology course. Few attempts were made to model effective integration into content areas or across disciplines or to develop methodologies for technology-based teaching. Other experiences involving technology within the pre-service programs were rare. New teachers were entering the classroom unprepared to cope with the technology that was already present and were unable to collaborate or participate in curricular efforts already underway in most schools.

Project KITES relied on learning and practicing technology skills and methodology simultaneously through active participation. The pre-service students in the program were taking their first professional education course. They had not taken the required educational technology course. They had not spent the many hours reading, observing, and reflecting normally thought to be essential before applying the skills in real situations. Despite all of the traditional objections, the project moved forward with astounding results. Students emerged with technology and teaching skills and the awareness that they had actually been part of a real integrated learning experience.

Description of the Activities of Project KITES

Project KITES was unique and different because it provided pre-service teachers with "hands-on" experiences with elementary students and technology and gave them opportunities to develop potential strategies using computers in their own classrooms. All of the activities in Project KITES focused on integrating computer technology into language arts instruction.

In the first activity, each pre-service teacher and his/her fourth grade counterpart read the same book and collaborated on a book report using the Slide Show Component of *Kid Pix* 2. Some of the college students were surprised by the amount of violence in children's books, and this sparked a debate on censorship and its role in the project. The college students decided not to dispute the children's selections.

One of the books in question was R. L. Stine's *Beach House*. The story is about a killer who travels back in time and causes one of his victims to be eaten by sharks. The Slide Show Component of *Kid Pix 2* contains several QuickTime movies including one of a swimming shark (accompanied by the theme from the movie *Jaws*). The fourth-grade student shrieked in excited terror and delight as the shark swam toward the doomed swimmer she had created as part of her slide show.

Another student created a slide show on *The Indian in the Cupboard* by Lynne Reid-Banks. The fourth-grader and his college friend scanned pictures of Native Americans from a variety of books and incorporated them into their slide show. In addition to scanned images and movies, students used microphones to add sound effects or to read portions of their reports. Other book reports included such favorites as *Charlotte's Web* by E. B. White, *The Big BFG* by Roald Dahl, and *Owl Moon* by Jane Yolen.

The second activity was named "Fourth Grade Friends" by the fourth-grade class. The fourth graders at the University Lab School were looking forward to a visit from teachers from Cameroon. They thought it would be exciting to correspond with fourth-grade students in that country and wanted to use technology to create their introductory letters. They also thought it would be fun to include the fourth-grade students from another class in the activity as well.

This activity involved using *The Writing Center* to create individual newsletters introducing themselves, their friend from the other class, and their college teammate to students in Cameroon. Students in Ms. LaHoye's Project KITES fourth grade class interviewed their friends in the other class to gather information for their newsletters, and the QuickTake camera was used to take pictures that were digitized for the newspapers. The fourth-grade students and their college friends planned their newsletters during prewriting sessions and then went to the computer lab to create and print their newsletters.

The third activity involved a research project. The fourth-grade students collected data about something they were interested in researching, such as favorite television shows, favorite restaurants, soft drink preferences, or types of pets of their classmates. After the data was gathered, the students used ClarisWorks to create charts and graphs depicting their data and then wrote a "lab" report of their findings.

Results

College students were interviewed to determine how participation in Project KITES had affected them. How had their perception of the teacher changed? What had they learned about themselves as a result of working directly with students? Had they experienced any changes in their perception of elementary students or discovered ways to integrate technology in their instructional practices?

Changes in Perceptions of the Role of Teachers

Before becoming involved with Project KITES, many of the college students adhered to traditional perceptions of the role of the teacher. The teacher was the instructional leader who stood at the front of the class and had little interaction with students. As a result of Project KITES, the pre-service teachers were beginning to change their perceptions. Natalie said, "I have never had a teacher, in all of my grammar and high school, who did not stand up in the front and talk. Ms. LaHaye (Project KITES fourth-grade teacher) is the only teacher I have seen that didn't do that. It's wonderful the way she just stands in the back or one the side and watches us work."

Katie stated, "Whenever I thought about being a teacher I always pictured me up in the front and all of my little students gathered around in front of me and I was kind of above them. I know that sounds bad, but I always figured that I was the one in charge, and I'm going to tell them what to do. But the more we started doing this, the more I started realizing that you learn from the students as much as they learn from you, so I guess my perception of teaching changed to a more interactive kind of thing."

Perceptions of Elementary Students

The pre-service teachers' perceptions of elementary students also changed because they began to view students as individuals. Kelly said, "It (this project) has made me realize that I am not teaching a classroom with thirty-two people in it. I am teaching thirty-two individual students, and it is important not to look at them as a whole but as individuals."

The preservice teachers discovered that students learned at different rates. Beth wrote, "I sometimes want to get in a hurry, and I have to tell myself to slow down. I don't want to rush John and I don't want him to get nervous. I want him to feel successful and use his imagination and be creative. I don't want to pressure him."

What Pre-service Teachers Learned about Themselves

Many of the college students had little experience working with students in an academic setting and were apprehensive. However, through Project KITES, the college students gained confidence in their abilities to work with elementary students in academic settings because they felt successful. When asked what she learned about herself as a result of this project, Kelly answered, "I learned that I could do it (teaching)." Michelle wrote, "I think I have learned that I will enjoy teaching. I totally enjoyed working with Amanda and felt so good when we, together, figured something out on the computer."

Catriona commented, "At the beginning of the project, I was very nervous about everything. I was worried about getting along with my partner, that she wouldn't enjoy working one-to-one, and that I just wouldn't do well teaching her how to use a computer. I have learned that with kids, it's simply a matter of being yourself and letting them be themselves."

Change in Perception of Using Technology in Classrooms

Many students mentioned that Project KITES took the "edge off" of using computers and that their anxiety levels were greatly reduced. Kelly stated, "Before, I was thinking, 'I don't even know how to work a calculator, and here you are going to make me do some slide show?' When everybody first started talking about using technology in education, I thought that it was going to be for the teachers to average grades. That was going to be the extent of it, and I know how to average grades in my head, so I would never have to deal with that. I am amazed that I am actually able to do it."

The college students also mentioned that the fourth-grade students' attention span seemed to be longer when they were working with computers. Jenny said that when she and her fourth-grade partner were doing pre-writing activities with paper and pencil, her student would complain that he was too tired to write and ask, "How much more do we have to do?" But when they were in the lab together, the student worked quickly to finish projects because he had other things he planned to do using the computer.

Benefits of Participation in Project KITES

There were many benefits of participating in the project. The one that seemed to be mentioned the most by the college students was the opportunity to work with real elementary students. They felt much more prepared for their entry into real practice which occurs in their senior year. Perhaps the words of one student, Kelly, best summarized their feelings: "For me, it was getting to work with a student. This is a real live fourth grader. It wasn't someone reading this hypothetical situation out of a book. This was a live little kid who went home and ate cookies and watched cartoons and she came to school. She is someone who could just as easily have been in a classroom whenever I teach. She was not a child prodigy genius or anything. To me, I got to teach her something. And I was learning it too. That made me feel good. I got to teach someone something and I am not a teacher yet."

Perspective of the Classroom Teacher, Sue LaHaye

Project KITES was a truly collaborative effort with many people involved. I believe that all of us, the college professors, myself, the fourth graders, the college students, the parents, and our school administrators, have seen it as a wonderful learning experience that has enriched education at our university and laboratory school in many ways.

Changes in Fourth-Grade Students

As the project progressed, I could see many positive outcomes in my fourth-grade students. One of the most significant changes has been the attitude of children about computers. They no longer see the computer as a thing with which to play games. They now view it as a tool for learning. They are beginning to think in terms of how to do a lesson and how to use the computer to enhance this lesson. They often comment on software that they have at home and how it could be used in a certain subject. Participation in the project has changed their attitude on learning. They now exhibit excitement rather than dread about learning new things.

Support of the Parents

There have also been changes in the parents. The parents have been most supportive of the authors and the project. Several parents have told the authors that they were delighted that their children know more about computers than they do. Some of them were now letting their children teach them about computers. One parent commented that she is so proud that her child is teaching her.

The parents have pointed out the special aspect of the one-on-one contact with the college students. There has been real bonding between the children and their partners. The spirit of the group as they simply walk to and from the lab has been marvelous. The children have fallen in love with the college students. Many of the parents are so busy, they don't have time to work with their children. The education students have filled a real void and have matured as they have learned to support and encourage the students. This has resulted in positive changes in attitudes in schoolwork and self-image of the children and the college students.

Changes in College Students

This project has also been beneficial to the college students. In one conversation, Sue LaHaye commented, "When this started, they (the college students) were uptight about entering the classroom in a real teaching situation. They were uncertain about how to teach children to do anything. They have grown into very comfortable education students who really enjoy teaching students to do things and who really enjoy learning with students. They found out that teaching might be difficult at times but that it is really rewarding in the end. They will not be so apprehensive about embarking on new projects in the future. They learned that it is okay if it fails. They seemed to find comfort in the fact that sometimes none of us knew the answers, but often we could explore together and find a solution."

Conclusions

Project KITES engaged pre-service teachers and fourth-grade students in authentic learning experiences that tapped their creative energies and fostered positive interactions. These activities also permitted pre-service teachers to gain confidence as they worked with elementary students in academic settings and provided a risk-free environment for pre-service teachers and elementary students to explore and learn together. Shared literary experiences allowed pre-service teachers to develop ways to integrate various software programs into instructional practices and provided new and varied literary experiences for fourth-grade students. In addition, the fourth-grade teacher was a willing participant in the project and began to develop ways to integrate technology into her teaching practice as well.

The software programs were easy enough to provide everyone with tangible successes. The pre-service teachers and fourth-grade students were excited about learning, and a community of "friends" developed. One pre-service teacher remarked that she was attending her partner's soccer game on Saturday. Another said that while walking in her neighborhood, she was surprised to see one of her fourth-grade students. "Hey! Aren't you in my computer class?" he asked.

Project KITES has reduced the anxiety of pre-service teachers with regard to interactions with elementary students and technology. Some pre-service teachers had no prior experiences in elementary schools. As we approached the elementary school on the first day, one exclaimed, "We're not really going in there, are we?!" Another confided that she was really frightened about creating a slide show book report. "I was afraid that he (her partner) would want to create these really elaborate pictures, and I wouldn't know what to do! But it all worked out just fine."

Project KITES provided pre-service teachers with opportunities to grow as educators while realizing the potential of technology as a tool for learning. These experiences are important because they build a foundation for future interactions and help pre-service teachers gain needed confidence about their abilities to work with elementary students. These experiences also cause pre-service teachers to reaffirm or reconsider the decision to become a teacher. Plans to continue the program in other settings and grade levels are being developed.

The challenge now is to build on this foundation and continue to integrate other technology-based experiences into future classrooms and activities. These students may emerge from the program with very few actual credit hours in educational technology. The hypothesis is that they will leave the program with the skills and confidence needed to use technology effectively in school environments and to become full partners in the technology community present in the schools they enter.

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Innovative Ways of Integrating Technology into Student Teaching Experiences

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Elementary teacher education programs have attempted to provide students with models for mathematics and science instruction based on the current recommendations of the National Council of Teacher of Mathematics (1989, 1991) and the American Association for the Advancement of Science (1989). These models incorporate the belief that technology is the tool that will prepare today's students for life beyond the year 2000. Moreover, an important component of all elementary teacher education programs is student teaching. Frequently, teacher educators are dismayed when student teachers do not see the most recent instructional methods and materials, learned about in coursework, modeled by their cooperating teachers.

Introduction

Observations of elementary mathematics and science teachers present a disturbing picture of current practices in elementary schools. Because of their lack of confidence in mathematics and science, elementary teachers sometimes choose not to teach mathematics and science and instead favor subjects with which they are more comfortable. Further, despite the development and dissemination of materials, programs, and recommendations for instruction, much of elementary mathematics and science instruction is still textbook and worksheet based, contrary to the positions espoused by the National Council of Teachers of Mathematics (NCTM) (1989, 1991) and the American Association for the Advancement of Science (AAAS) (1989). Textbook-based instruction in mathematics often focuses on lower level skills with little attention to the development of conceptual understanding and problem solving ability. Similarly, science is typified by exercises in reading comprehension and the memorization of vocabulary, where material is presented out of context with little attention to problem-solving and thinking skills. The primary use of technology in science and mathematics at the elementary level continues to be drill and practice activities (Becker, 1986).

In contrast, NCTM and AAAS envision students investigating problems within a real world context with the use of interactive video and CD-ROM technology. Students' problem-solving will expand beyond the limitations of their personal computational abilities as technology is used as an analysis tool. Likewise, students will have the capability of presenting their findings to their peers with exciting presentation packages. These activities will occur in classrooms that attempt to mirror reality by using the team approach to work on projects that span the content areas.

Reflection on this matter suggests several reasons why student teaching experiences do not provide instructional models with currency. First, student teachers are not encouraged to use the most current methods because their cooperating teachers lack knowledge about those methods. When the new method involves technology, cooperating teachers may feel that they have little to offer in terms of directing their student teacher charges. Second, student teachers may not be encouraged to try suggested methods related to mathematics or science because either the cooperating teacher or classroom students feel less comfortable about math and science and tend to stick with tried and true methods. Third, many school settings do not provide the necessary equipment and software for instruction through technology .

One strategy for overcoming these serious hindrances to using technology during student teaching is to work with teams of student teachers and their cooperating teachers to ensure comparable understanding of technology and its benefits and sufficient knowledge to use the technology appropriately. This strategy was implemented in an Eisenhower grant that allowed us to conduct the Interactive Video Institute (IVI).

The Interactive Video Institute

The IVI involved three phases: recruitment, training, and follow-up activities. In the initial phase, pairs of student teachers and their cooperating teachers were recruited to participate in the project. Sixteen student-teacher/cooperating-teacher pairs and four unpaired teachers participated. These pairs taught at grade levels 2-8 with the majority of them teaching at intermediate grade levels. Although teacher and student teacher participants received a stipend for their participation in the IVI summer training, the researchers found it difficult to recruit pairs of participants due various scheduling conflicts.

In phase two, intensive training covered six hours per day over a two-week period in the summer. Assisted by five faculty members from a college of education, two school district employees with expertise in computer integration led the training. They focused on a variety of components, both technological and pedagogical, including use of equipment, use of specific software, management issues related to the use of equipment in the classroom, problem solving, and cooperative learning. Teams of two pairs were assigned a moveable multimedia station for use during the institute and the following semester. Each station included an Apple Quadra 660 AV with CD-ROM, a 14" monitor, a printer, a 20" video monitor, and a Pioneer 2600 laserdisc player. Initial sessions of the summer workshops focused on the use of the equipment. Participants were required to demonstrate the appropriate set-up of the equipment after it had been taken apart or sabotaged (e.g., cables were disconnected). Subsequent sessions included introductions to and explorations of specific software packages, such as *ClarisWorks* for word processing, spreadsheets, and databases. Next, participants learned to incorporate CD-ROMs such as *Animals* into instructional units. Problem solving instruction was discussed as participants learned to use *Jasper Woodbury*, *Science Sleuths*, and the *Great Ocean Rescue*. Finally, participants learned to use presentation software and developed their own interactive presentations using *HyperStudio*.

We encouraged participants to think about both technology and pedagogy to develop a sense of how multimedia equipment and materials could become an integral tool in the classroom teaching/learning process. As the summer program progressed, participants had opportunities to develop materials aligned with their districts' curricula for use in their classrooms during the following semester. A typical workshop day consisted of training on a topic, opportunities for hands-on practice, time for developing instructional materials, opportunities to reflect through writing, and opportunities to share successes and challenges from that day of the workshop.

The third phase of the project, which consists of observations, logs, reflective journals, and follow-up meetings, is currently in progress. Project directors are observing student-teacher and cooperating-teacher participants using technology to aid math and science instruction. Cooperating and student teachers maintain time and use logs. They also maintain a reflective journal addressing their use of technology coupled with problem solving and cooperative learning strategies, as well as evaluative descriptions of their activities involving technology. The elementary students of the participants write in journals, at least monthly, to describe the use of technology in their own thematic, group projects. Monthly follow-up meetings allow participants to share successes and to trade software. In the remainder of this paper, we present the results and discuss the successes and challenges that we encountered in the IVI project.

Methodology

Subjects

Thirty-six participants attended the summer institute, 20 teachers and 16 student teachers representing six urban schools from five school districts. Of those, thirty-three completed the final evaluation, 18 teachers and 15 student teachers. Participation was voluntary.

Instrument

On the final day of the summer workshop participants were administered a questionnaire containing both Likert-type and open-ended items. The Likert items used a five point scale. A response of 5 indicated strong agreement, a response of 1 indicated strong disagreement. An example of an item is: "The institute activities are relevant to my classroom needs". Responses to the 35 items were grouped to form the following seven subscores.

- (UNDERSTAND) Perceptions of increases in understanding and the ability to use technology in the classroom
- (INTEGRATE) Potential of IVI learning to be integrated into classroom instruction
- (USEFUL) Perceptions of the usefulness and relevance of the materials
- (PEERS) Level of sharing with and learning from peers
- (NEEDTIME) Need for more time to explore the materials
- (BASESKILL) Perceived level of computer expertise prior to the institute
- (SOFTWARE) Rating of the software introduced during the institute

In addition to the Likert-type items, participants responded in writing to five open-ended questions concerning the summer program.

Results

Likert Items

The Likert items were group into seven categories. Mean subscores were computed for each category separately for teachers and student teacher (See Table 1). Independent t-tests by group for each category found no significant differences between teacher and student teacher responses. With the exception of BASESKILL, which was expected to be lower, means were high indicating positive perceptions.

Table 1
Means and standard deviations of subscores by teacher and student teacher

Subscore	Teacher Mean	Teacher SD	St Teach Mean	St Teach SD
UNDERSTAND	4.68	0.40	4.80	0.29
INTEGRATE	4.54	0.43	4.60	0.36
USEFUL	3.88	0.62	4.12	0.59
PEERS	4.81	0.25	4.63	0.35
NEEDTIME	4.06	0.75	3.80	0.70
BASESKILL	1.33	0.23	1.33	0.24
SOFTWARE	4.37	0.28	4.45	0.32

Open-Ended Items

Responses to the open-ended items were analyzed for general trends and recurring thoughts. Responses which typified the consensus of responses for each were identified. As a result, one-of-a-kind responses have not been reported. The responses of the teachers and student teachers were collapsed when they were similar in content.

What is the most positive aspect of the institute? Seventy percent of the student and cooperating teachers (25/35) cited opportunities for exploration of technology and their increased confidence in using technology. Examples of responses were:

- Being able to explore *HyperStudio* and having the time to explore programs and laser discs
- The time allowed for free exploration after the presentations
- Gaining a level of comfort with technology
- t opened up a world of teaching opportunities I would have not experienced otherwise, and has given me confidence to try to use them in my class, when available.
- Simply finding out what is out there! Before the institute, I knew very little about computers & programs. Some programs I had only heard of, but most everything seemed unreachable. Everything seems doable now. I can do it!
- Being able to see how technology can be used in the classroom to teach certain concepts

What are the factors needing improvement? About 43% of the teachers (15/35) responded that they needed more time to learn to use the programs or that there was too much to cover in the allotted time. Examples of responses were:

- More time - more days
- We needed more time to preview software, but I understand why that was difficult.
- I would have liked to get to practice more with *HyperStudio*, etc.
- The amount of information given . . . concentrate on a few areas to allow us to become experts.

List three new ideas from the institute that are directly applicable to your classes. In response to this item, about 78% (14/18) of cooperating teachers and about 35% (6/17) of student teachers named the programs they learned to use during the institute, for example, *KidPix*, *HyperStudio*, *ClarisWorks*, *Graph Club*.

About 67% of the cooperating teachers (12/18) and about 12% of the student teachers (2/17) listed opportunities for curriculum integration. Examples of responses were:

- The idea of allowing students to create a total presentation using technology
- Using video "photos" to illustrate student writing
- Having students collect data, graph it on the computer, and create and solve problems related to the graphs
- Using *Windows on Science* (scanning barcodes) to illustrate science lessons, animal reports, etc.
- Using technology like *Fizz and Martina* for math problems solving
- Writing research reports on *ClarisWorks* & *KidPix*

About 31% of the participants (11/35) mentioned big picture ideas regarding cooperative learning, problem solving, and the one computer classroom. Examples of responses were:

- Working with one computer in the classroom
- It's helped me think more globally & thematically for my special education kids rather than just specific skills.
- Cooperative groups of children inventing with computers
- A new way to reach a lot of kids who otherwise lose interest
- Using the process more than content

As a cooperating teacher, how did this experience give you a better perspective of your student teacher? Teachers generally felt positive about the experience. Examples of responses were:

- It was wonderful to meet my student teacher on neutral ground and get to know her personally before getting into the classroom.
- She's very patient & calm in stressful situations. We seem to agree on educational philosophy. She has a lot of ideas & is open to new ones.
- I was able to work with my student to plan for the fall semester. I was able to see what knowledge she will bring to our classroom and what goals she wishes to attain.

- I got to know her better as a person first. Having lunch breaks were a great way for us to bond. We really needed that time to find out about one another. Because we did that sharing, we worked well together. What a luxury to find out her areas of expertise! She's a gem.

As a student teacher, how did this experience give you a better perspective of your cooperating teacher? About 65% of the student teachers (11/17) were quite positive about the working relationship they developed. Examples of responses were:

- Yes! I feel much closer to her than I would after a month in the classroom. I feel freer to ask questions and give comments.
- It gave me an idea of what it will be like to work with her. It was fun.
- After spending two weeks with my cooperating teacher, I feel much more comfortable with her. I know a little more about her personality and her teaching style.

Follow-up

Data collection for the project is ongoing. Participants are attending monthly follow-up meetings, being observed, and maintaining computer use logs and journals. Preliminary results of the observations and analysis of the teacher journal entries, as well as teacher self-reports at the monthly meetings, indicated that teachers are using technology in their classrooms. Participants used the materials in their classrooms in two ways. First, they used existing instructional programs, such as *Fizz and Martina*, *Windows on Science*, and the *Great Ocean Rescue*. Second, they used *HyperStudio* and *KidPix* to create presentations. These presentations ranged from class magazines, to individual student reports, to demonstration programs for parents on conference nights.

Discussion

This project was conducted to prepare cooperating and student teachers to use technology in the classroom during the student teaching experience. The essential question examined in this report is how effective was the training. The effectiveness of the program was examined from three points of view. First, were the participants able to learn enough in a two-week period to feel comfortable and competent in using multimedia in their classrooms? Second, did the teachers integrate the technology for the summer program into their class curriculum? Third, did the pairing of cooperating teachers and student teachers increase the likelihood that technology would be applied in classrooms?

Although we are still collecting data in the follow-up phase, it appears that the participants did developed both competence and confidence in using technology during the two-week institute. Participants' self-perceived level of computer expertise at the beginning of the institute (BASESKILL) was low with means of 1.33 and 1.33 for cooperating and student teachers, respectively. By the end of the institute the participants rated themselves relatively high in understanding technology with means of 4.68 and 4.80 for cooperating and student teachers, respectively. Although the means were not responses to the same items on a pre- and post-test instrument and cannot be compared as such, they do indicate that by the end of the institute the participants perceived that their understanding had increased. This possible increase in competence and confidence is verified by responses to the open-ended questions. The majority of teachers regarded the opportunity to develop confidence in using technology as one of the most positive aspects of the institute.

It also appears that the IVI participants have integrated what they had learned about technology into their classrooms. On the evaluation instrument, both cooperating teachers and student teachers tended to agree that there was potential to integrate things they had learned at the institute into their classrooms (INTEGRATE) with means of 4.54 and 4.60, respectively. They also tended to agree that the materials were useful and relevant (USEFUL) with means of 3.88 and 4.12, respectively. The perception that the technology could be integrated into class curricula was validated by responses to the open-ended questions. Teachers responded that they had seen how technology could be used in their classrooms and listed several specific possible uses, for example, using video photos to illustrate children's writing, having students collect data and graph it on the computer, and using *Windows on Science* to illustrate science lessons.

Preliminary follow-up data also indicate that teachers are using technology in their classrooms. Although teachers had indicated their excitement while exploring various multimedia products during the institute and their realization that technology can be used in conjunction with classroom curricula, it appears that the observed and self-reported integration does not reflect a large degree of individualization. The preliminary data indicate that the teachers are using the materials in their classroom the way the programs were modeled during the institute instead of as the basis for original activities.

This apparent lack of innovation during the follow-up semester in school may be related to lack of time for planning integrated lessons during the school year. During the summer workshop teachers were introduced to and explored a wide variety of materials, and they were allowed time to plan the use of those materials in their classrooms. However, it is unrealistic that teachers, especially with relatively low baseline skills in computers, would master all the software over a two-week period. Cooperating teachers and student teachers agreed that they needed more time working with technology during the IVI with NEEDTIME means of 4.06 and 3.80, respectively. Lacking time for further exploration and lesson development, teachers may be choosing to use the materials that required the least amount of effort to implement. These results are consistent with the literature that shows the implementation of innovation requires extended time periods (Fullan, 1991).

Finally, we wanted to investigate the effect of pairing cooperating and student teachers on the likelihood that the technology would be used in the classroom. It is apparent from responses on the evaluation that the participants perceived the cooperative atmosphere of the IVI as positive. Cooperating teachers and student teachers concurred that they had learned from peers during the IVI and planned on continuing this sharing process with means for PEERS of 4.81 and 4.63, respectively. On the open-ended items, both cooperating and student teachers commented on the value of meeting their partner for the coming semester prior to the student teaching experience, but comments did not focus on the issue of technology implementation.

Preliminary follow-up data indicate that both cooperating teachers and student teachers are using the technology in their classes. Although we cannot attribute this use of technology to the pairing of the cooperating and student teachers, it is clear that they use technology on a regular basis in their classrooms.

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Integrating Technology in Preservice Education: A Model For Faculty Development

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This paper follows an earlier work in which we discussed the strengthening of a teacher education program through the building of a technology enhanced classroom. In that paper, we propose that the acquisition of a technology enhanced classroom needs to be followed by an aggressive faculty development program to insure full integration of technology in the preservice program. The approach to faculty development that we have outlined takes participants through a series of overlapping and continuing phases: familiarization with hardware and software, partnering with mentors, developing individual projects, and becoming mentors (Kortecamp and Croninger, 1994). This paper details progress in technology-centered faculty development in the teacher education program at the University of New England (UNE).

Faculty Development

Historically, faculty development has never been a priority item in the budgets of American colleges and universities. Until the 1970's, the primary purpose of faculty development programs was promoting traditional scholarship e.g., reading, writing, and study. Support took the form of time-off or travel funds so that faculty could pursue their own interests. The impetus for expanding faculty development activities aimed at improving teaching competencies arose from criticism of teaching by college students on several campuses in the 1960's (Elbe & McKeachie, 1985). Lunde and Healy (1991) describe the continued evolution of faculty development:

> Over the past fifteen years, the phrase faculty development has emerged as the umbrella term for most faculty-centered approaches, at least general usage. It stands for a collection of those activities designed to encourage the faculty members to improve and to grow by making planned changes in their expertise, skills, attitudes, career path, or personal lives for the betterment of the individual, the students, and the institution. (p. 2).

The explosion in technology in the last decade has placed enormous financial and faculty development pressures on public schools. Concurrently, the growing expectation held by many school administrators and the public at large is that today's beginning teachers will be computer literate and familiar with educational computer programs. Small teacher education programs often find the costs associated with developing technology literate teachers outside the range of their meager operating budgets . At the University of New England, teacher education faculty have worked with other faculty on campus to devise creative strategies for the acquisition of hardware and software (Kortecamp & Croninger, 1994). With the support of the academic computing committee, this group has developed a model for delivering the training and education programs necessary to enrich the teaching competencies of established and entering faculty members. By enlarging the client pool and sharing resources, teacher education faculty are able to engage in the professional development necessary to successfully integrate technology in the preservice program.

The model for faculty development in information technologies consists of five components which overlap and are ongoing:

Familiarization with hardware and software,
Partnering with mentors,
Developing personal projects,
Becoming mentors, and
Keeping current with new knowledge, and technologyinnovations.

Keeping current with new advances in technology and new knowledge about teaching and learning is integral to the program and impacts on all components. Though it may suggest a linear progression from one component to the next, the model is not limited in this way. For instance, it is not necessary to attend initial workshops in order to link up with a mentor who assists in the development of a personal project or to become a mentor.

In constructing the model, distinctions were made between training and education. The term training is commonly used to define all activities associated with professional development and, in particular, those related to learning information technologies. While "technology training" has an alliterative appeal, not all professional development activities can accurately be called training. According to Pulliam and Patten (1994), "Training perpetuates existing information and reinforces current trends. It is usually a memorization/regurgitation, short-term method of learning". Education, on the other hand, involves the study of what is known in order to facilitate new questions and new answers. During industrialization, training was an asset. In the communication era, training does not equip learners to make decisions, solve problems, and think creatively and critically.

Both training and education are necessary in learning how to fully utilize technology in teaching. In our model, familiarization with hardware and software is a training component. Though the partnering with mentors, project development, and becoming mentors components may require some training, the emphasis in each is on educating faculty. It is essential to provide activities which encourage faculty to share sources of information, risk making mistakes, and cooperatively analyze and solve problems. These are, after all, competencies we want to see in our preservice teachers.

Implementation of the model began in May, 1994. Faculty and administrator response to the program has been very positive, yet obtaining financial support continues to be a struggle. In October, an assessment of the university's information systems was conducted by an outside firm. The report indicates that the university is seriously deficient in its budgeting and planning for maintaining and upgrading information technologies. In response to this report administrators have pledged a significant increase in the portion of the budget allocated to information technology. A major share of these new monies will be dedicated to increasing computer services staff in support of faculty development needs. Because faculty development is the scaffold necessary to support teacher education faculty in their efforts to model the use of technology in teaching and learning, we view this as a major step in advancing our program.

Familiarization

This phase of the model is a two step process. The initial step is to inform faculty about the technologies which are currently available. On our campus, these include a computer enhanced teaching space and two mobile, liquid crystal display (LCD) projection stations for use in any classroom. A second enhanced teaching space is a multimedia classroom that offers audio and video projection and laserdisc and compact disc-read only memory (CD-ROM) players. In addition, this classroom offers access to the campus local area network as well as distant electronic bulletin boards via modem.

A "show and tell approach" has proven very effective in stimulating faculty interest in learning about and using technology equipment and enhanced teaching spaces. Faculty participation in these sessions is viewed as a critical first step in bringing about the infusion of technology in the preservice program. Broad discussions of possible applications of technology in teaching are encouraged following demonstrations of a variety of software programs that support the instructional process.

The second step in this component of the model is a series of focused workshops designed to provide faculty with the competencies necessary to independently operate equipment and maximally use teaching spaces. Written instructions detailing set-up and utilization accompany the verbal directions given during each workshop. A troubleshooting guide is included.

Partnering with mentors

Ritchie and Wiburg (1994) state that skills and knowledge gained in workshops frequently are not transferred to professional activity because of the lack of ongoing assistance and development. Coaching is one approach that can be used to sustain the cognitive momentum created through workshops as faculty explore implementing new skills and knowledge in their teaching.

In this second component of the model, novice users of technology are paired with more experienced faculty who serve as mentors. The emphasis is on individual needs. Mentors assist their partners by clarifying concepts, discussing problem areas and collaborating to find workable solutions, and tutoring in the use of hardware and software. Through this process, novice faculty gain confidence in their ability to thoughtfully integrate technology in their teaching.

Development activities initiated by the mentor or the novice may warrant both training and education. When partnering activities focus on using hardware and software, as in the initial workshops, the novice is receiving training. Examples may include the acquisition of basic skills such as connecting a laptop to the campus network or formatting a class lecture using presentation software. As the mentoring partners engage in analyzing software, applying prior learning to new situations, solving problems, and evaluating the effectiveness of those solutions, development activities center on education. Several projects have been advanced through the novice/mentor relationships.

Project Development

Teacher education faculty are expanding the integration of technology in the preservice program in a number of ways. Three common approaches taken in our program are modeling, facilitating activities that directly involve students, and placing our students in technology friendly field sites. Modeling the use of computers and other equipment takes place in the methods courses. In the science methods course, for example, direct teaching is supported with a visual outline of new material using the presentation program, Microsoft PowerPoint. A more direct approach to modeling involves students in the process. Preservice teachers, working in small groups, generate collaborative solutions to situational problems. A recorder maps the group's thinking using word processing. Each group then presents their ideas to the whole class using an LCD projector and a computer. The contributions of each group are saved, printed, and distributed to the class for future reference. Updating and expanding students' work is easily accommodated as well. The use of technology to facilitate collaboration is experienced first-hand.

Faculty have designed activities and projects that require preservice teachers to use technology in meaningful ways. Preservice teachers are evaluating software in the writing, language arts, and science methods courses. Several features of a variety of programs are reviewed including graphics, help screens, options, interactively, content, and possibilities for higher level thinking. Before fully judging the overall effectiveness of programs, preservice teachers are encouraged to explore the programs with K-8 students in the field placement sites whenever possible.

Our preservice teachers examine the use of technology as a tool for integrating content as they develop units of study in the science methods course. As part of the assignment, students in the program must design learning experiences that blend science content and other content areas using some form of technology e.g., calculators, overhead projectors, computers, video equipment, and so on. A follow up assignment requires that the student implements the learning experience in a K-8 classroom. Once all students have met the requirement, the course instructor facilitates a discussion of the benefits and difficulties associated with technology use in the classroom.

Of the five components in the model, the development of personal projects has been the most constrained by limited resources. A proposal submitted in fall of 1993 for a Macintosh teaching lab was not funded by the university. Teacher education faculty had planned extensive use of this proposed space. A revised proposal for a Macintosh cluster consisting of three computers and software was funded. The new Macintosh's have been used to establish a "developer" area with the cooperation of the university media center. The campus local area network (LAN) has been extended to this space. One of the media center machines is outfitted with video capture equipment.

To facilitate the use of technology by our preservice teachers we are working on the creation of a set of templates in Hypercard and Hyperstudio. These templates will serve as a background for student projects in content areas such as science and history. Each template is an electronic "canvas" upon which the student could place the graphics and text necessary to develop a topic. Graphics could include still pictures or Quicktime™ movies while text could be in written or spoken form. The major advantage to these templates is to decrease the amount of computer programming preservice students need to learn.

The design of the templates will require that we automate the placement of the graphical components. Rather than learning programming the student will need only to select "create graphic" from a menu, select the graphic from a list, and then drag it to the desired location on the template. The template itself should then add the scripting necessary to automate the appearance and location of that graphic. The templates will serve to decrease the "cognitive load" incurred by students attempting to evaluate the usefulness of technology in teaching. Hooper (1990) writes that "active involvement by students in manipulating information is key to their success in learning". Evaluative reports written by first year faculty involved in a multimedia project, identified improvement in their ability to sequence, use of graphical information, and ability to present verbal information more clearly as outcomes of their experience (Todd, 1993)

A final project presently underway, is a collaborative writing of a grant proposal. If funded, the grant will support a technology partnership between the teacher education program and a public school system. The current plans envisions college students using the internet to communicate with K-8 students during the school day. Teacher education students in the writing methods course, for example, will keep dialogue journals with K-8 students in the partnership school. The ongoing written dialogue will be used to encourage children to write, to assist them in their development as writers, and to provide preservice teachers with opportunities for assessing writing progress.

Clearly, as faculty devise strategies for integrating technology in methods courses the stress is on educating preservice teachers. Attention is centered on how to enrich teaching and learning experiences through technology use rather than how to set up equipment. The computer applications course that all program students are required to take prior to enrolling in the methods courses addresses most of the training needs of students. Although, in some cases, instructors in methods courses have taken on the role of trainers, particularly when specific software (i.e.., Hypercard & Microsoft PowerPoint) is required. In the development of all of the projects described, the support of a mentor was critical. The mentors shared knowledge with novices or learners, made learners feel more comfortable with technology, coached learners to pursue personal development interests, and collaborated with learners in solving problems as they arose.

Becoming Mentors

The two most important characteristics necessary to become a mentor are knowledge of specific technology use and a willingness to share that knowledge with other faculty. The second characteristic implies that the mentor is willing to give time and energy in support of someone else's professional development. Compensation is mostly intrinsic since there is not a budget to support the program, though mentoring is recognized as service.

In this first year of the program, three members of the academic computing committee volunteered to serve as mentors. Since the level of involvement and commitment of time vary with each project and because the initial number of faculty being served by the program is small, this number has been sufficient to get the program off the ground. As demand increases, however, a larger pool of knowledgeable faculty is required. More than half of the faculty who have participated in the program as learners have expressed a willingness to serve as mentors for others. In certain cases, this has already occurred. One faculty member in teacher education has been assisting another in developing a computer generated presentation for a seminar class of cooperating teachers and teacher interns.

As with other components of the model, there is a need for both training and education in order to serve as a mentor. Opportunities for all mentors and their partners to come together to share ideas and experiences are provided by the academic computing committee. These meetings promote reflection and encourage learners to attempt new projects on their own.

Keeping Current

Given the rate at which technology has evolved in the last decade, even the most advanced users find staying abreast of innovations in hardware and software quite challenging. As an outgrowth of university information systems assessment, a campus wide technology policy and planning committee has been formed. This committee is charged with monitoring trends in information technologies, developing a long range plan for ongoing integration of technology, and formulating policies to guide the budgeting of funds for technology.

This committee will work with the academic computing committee (ACC) to identify new innovations in technology and new information about the use of technology in teaching and learning. The ACC operates as a forum for faculty to voice their needs regarding equipment, software, and faculty development. The technology policy and planning committee and the ACC work with computer services to acquire hardware, software, and to plan appropriate faculty development activities. The faculty development activities will continue to be a mix of both training and education.

Revisiting the Model

Integrating technology in teacher education programs is a necessity, not a luxury. Effectively applying technology is high on the list of what beginning teachers should know and be able to do in today's classrooms. Those who enter the job market without the requisite skills and knowledge will be at a distinct disadvantage. While monetary restrictions often limit the infusion of technology in preservice education programs, traditional pedagogy and concerns about whether mastering technology skills is the best use of faculty time, slow the pace at which instructional technologies are adopted (Ritchie & Wiburg, 1994; White, 1994).

A critical, but often neglected factor in effectively integrating technology in preservice education programs is faculty development. This paper details the five components of a comprehensive model for faculty development in use at the University of New England. The components are: familiarization with hardware and software, partnering with mentors, developing personal projects, becoming mentors, and keeping current with new knowledge and technological innovations. Although the program is new, indications are that it effectively supports faculty as they initiate and implement projects that utilize technology in the methods courses. Many of the activities that faculty partners and preservice students participate in combine aspects of training and education.

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Designing a Hypermedia Portfolio for Preservice Teachers

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The use of portfolios for assessment is receiving increased attention in the education field. The increased use in the public school arena may be attributed to a desire to reflect student accomplishment in a manner other than that of a standardized test, which may reduce a complex individual's performance to a simplistic series of numerical averages. There are some advantages to such simplicity, but it may not do justice to the uniqueness of the individual.

Education journals publish descriptions of guidelines for portfolio use in the public schools. Preservice teacher programs include the study of how to design and use portfolios to evaluate student performance. Portfolios are sometimes used to evaluate the preservice teachers. There are advantages to having students apply what they are learning to their own experience.

Perhaps portfolios could be used to evaluate preservice teachers over the entire sequence of their professional development courses. Such a project would combine content and experiences from classes over several semesters. Retention of the information over time honors the progress that is made. Reflection over its content would provide insights regarding the breath and depth of an individual's preparation. At the same time, mentors or advisors could reflect on individual portfolios and obtain a sense of program strengths and/or weaknesses.

At the present time, there is little demand for portfolios by personnel directors of public school systems. Hiring procedures involve the submission of several standard materials, references, and the results of an interview. Graduation requirements at most institutions do not require portfolios. Why design one?

Rationale

If the idea for portfolios is an empowering one for public school students, leading them to reflect over and value their growth, then it would also seem to be a valuable exercise for preservice teacher participation in a meaningful way. The difficulty lies in the nature of the preparation and teaching portfolio. A teacher's "canvas" goes beyond mere paper and pencil. It involves rich content and experiences in myriad settings with diverse populations. A preservice teacher is certified to teach in many settings with different populations and using an endless possibility of materials. Displaying one's preparation for this is no easy task. The items that might reflect this complexity would be cumbersome to collect. How might the power of technology be harnessed to allow such a portfolio to be collected, stored, and preserved? The project has definite possibilities. If done successfully, the student would store work or work samples over time that would reflect the richness of their preparation. Through the use of technology, such a store would be accessible, economical, and easy to reproduce for distribution to a any place if the need arose.

The Hypermedia Portfolio

In an effort to explore the possibilities, two faculty members collaborated on a project to develop a prototype portfolio design. The hypermedia portfolio allows for storage of text, visual or photographic images, and video clips of events, people, and materials.

Content

The initial design includes the traditional items used to sum up a preservice teacher's experiences such as resume, references, transcripts/grades, evaluations, and papers with the topics "Why I want to teach" or "My philosophy of teaching."

New Elaborated Content

The new items for inclusion allow for an expansion of the traditional content. Greater detail may be provided in an easily accessible format. These additional sections could include multuple items of information that record real content and experiences.

- A section of items related to "knowledge" could include content such as course titles, texts used, professional reports created, and children's texts read and annotated.
- Greater detail could be provided about professional experiences with children. Lists of locations and student populations, field assignments, student teaching and substitute teaching experiences, tutoring and volunteer experiences could all be listed and supplemented by visual or video records.
- Professional development with peers could be included: conferences attended, course content, professional projects, memberships, service, and community work. Records of this activity provides insight into commitment to continued professional growth.
- Materials developed could be stored economically by means of recorded images. Lesson plans, units, visual aids, curriculum materials, and books accumulated for classroom libraries are a few of the items that could be included.
- Technology competencies could be documented and supported with examples.
- Professional papers could be included. This retention of course content honors the completion of the product. The list of paper titles, actual text of papers written, journal articles summarized, case studies and projects, and personal journals can reflect student interests and competencies.

The items listed provide a partial indication of the initial content that could included. The portfolios could take many different forms as individuals reflect over the image they wish to display. Materials could be retained over time but could also be easily composed together to serve a particular need.

Program Design

Using HyperCard™, a prototype storage medium was designed for portfolio content. The initial design would be dedicated to a single user. The content would include items commonly encountered in the course of a preservice teacher's sequence for professional development.

Initial content includes title screens and a main menu that allows the user to store items in seven areas: traditional resume items, knowledge/education area, papers written, materials developed, technology competencies, professional development with peers, and professional experience with learners.

Appearance

The HyperCard portfolio would provide each individual preservice teacher student with their own means of storing diverse materials. In storing the materials, the collective effect honors the individual's development.

Hypermedia
PORTFOLIO
achievement in teaching

Figure 1.

The main menu allows a selection of categories for consideration for inclusion. These categories could be utilized or the topics listed could be changed to suit the needs of the individual.

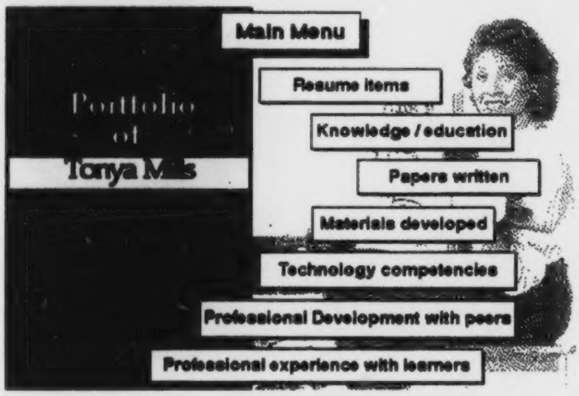
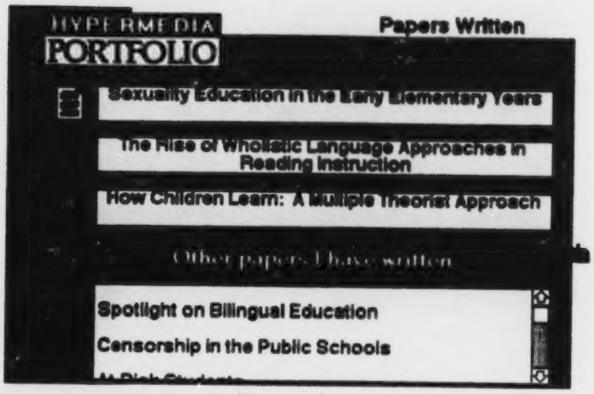


Figure 2.

Once a student selects from the main menu, they can enter data that fits in the category. In the category of "Papers written", students can maintain a list of titles of their best papers followed by a running list of additional titles as they write for different courses.

If desired, the content of a particular paper could be stored on the program for review.

The possibilities are endless. The limitations will be a function of technology at this time.



Papers Written

Sexuality Education in the Early Elementary Years

The Rise of Wholistic Language Approaches in Reading Instruction

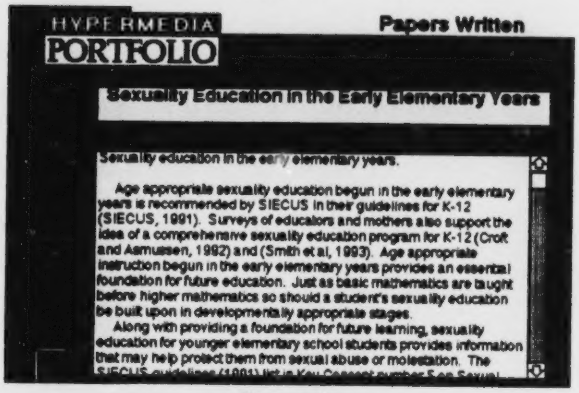
How Children Learn: A Multiple Theorist Approach

Other papers I have written

Spotlight on Bilingual Education

Censorship in the Public Schools

Figure 3.



Papers Written

Sexuality Education in the Early Elementary Years

Sexuality education in the early elementary years.

Age appropriate sexuality education begun in the early elementary years is recommended by SIECUS in their guidelines for K-12 (SIECUS, 1991). Surveys of educators and mothers also support the idea of a comprehensive sexuality education program for K-12 (Croft and Asmussen, 1992) and (Smith et al, 1993). Age appropriate instruction begun in the early elementary years provides an essential foundation for future education. Just as basic mathematics are taught before higher mathematics so should a student's sexuality education be built upon in developmentally appropriate stages.

Along with providing a foundation for future learning, sexuality education for younger elementary school students provides information that may help protect them from sexual abuse or molestation. The

Figure 4.

Additional information on the complete prototype is available from the authors (see address at the end of this article). The design will evolve as the prototype is demonstrated to other professionals for their input. The current design is an experiment in choosing categories for the prototype portfolio and in assessing limits that may be encountered as items begin to be stored.

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The Place for Technology in a Constructivist Teacher Education Program

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Many students enter teacher education programs thinking that imparting knowledge is the fundamental goal of teaching, and it probably still is. Instruction in schools is primarily the transmission of knowledge rather than the process of interaction and construction of knowledge (Brazee & Kristo, 1986, Shor & Friere, 1987). It is no wonder that the cliché that we are doomed to teach the way we have been taught rings frightfully true. Much evidence supports the notion that teacher education remains behavioristic with a didactic, one-right-answer approach dominant (O'Loughlin, 1989, Giroux & McLaren, 1986). Holt-Reynolds (1991) states that the experience and knowledge preservice teachers bring with them to teacher education "constrains as much as it illuminates, prejudices even as it colors, and short circuits as often as it leads to fresh insights."

A constructivist, process orientation to teacher education is essential if we are to encourage students to develop problem solving and critical thinking skills and to apply, analyze, synthesize, and evaluate knowledge, skills, and attitudes. Pre-service teachers should engage in these processes throughout the entire teacher education program if we have any hope for a constructivist approach in the schools. It is important to note that teacher education does not stop with the granting of a degree or license. Schools and universities must make an effort to improve their relationships to facilitate lifelong teacher education. Technology is a method that could assist with this endeavor.

Constructivism is defined by Piaget as a way of explaining how people come to know about their world (1969). Brooks and Brooks (1993) list the following as guiding principles of constructivism: posing problems of emerging relevance to students; structuring learning around primary concepts; seeking and valuing students' points of view; adapting curriculum to address students' suppositions; and assessing student learning in the context of teaching.

According to Giroux and McLaren (1986), school and classroom practices should, in some manner, be organized around forms of learning which serve to prepare students for responsible roles as transformative intellectuals, as community members, and as critically active citizens outside of schools. Craig, Bright, and Smith (1994) suggest that the actions of the instructor and the involvement of the students are essential components that must be addressed in teacher education to facilitate change in schools. Teacher education faculty must model constructivist, process instruction, and preservice teachers must be actively involved at all levels of the teacher education program.

Reitz (1983) states that what teacher educators do, not what they say, affects preservice teachers' learning. The actions of the instructor are important in a teacher education classroom. Craig, Bright, and Smith (1994) suggest that teacher education courses that are interactive and constructive may promote teaching practices that help students in schools to develop understandings of important concepts.

General goals for teacher education should include the following:

- ensuring that students feel comfortable and successful;

- promoting modeling, reflecting, involving students actively and developing a community of learners;
- providing experiences and expectations that help students reach their potential;
- generating a passion for teaching and learning;
- developing critical thinking and problem solving skills; and
- facilitating the integration of constructivism in teaching.

Four major themes that are central to a constructivist teacher education program that attempts to achieve the goals mentioned above include modeling, reflecting, involving the students actively, and developing a community of learners. The place of technology within a constructivist teacher education program applying these themes is the focus of this endeavor.

Technology is a major component of a constructivist approach and should be integrated throughout a program, not limited to one or two introductory courses. Information technologies are motivating, creative, interactive; they provide variety and promote meaningful learning (Seidman, 1986; White, 1992). The use of technology facilitates the goal of adaptive, individualized, and interactive instruction (Nickerson & Ziodhaites, 1988).

Objectives for integrating technology in teacher education beyond introductory courses include:

- developing an awareness of available hardware and software for use in schools;
- evaluating hardware and software available for use in schools;
- applying packaged software during all preservice teacher education experiences;
- applying emerging technologies including multimedia and telecommunications during all preservice teacher education experiences;
- developing lessons and units integrating technology; and
- engaging in problem solving activities regarding availability, training, budget and influence of traditional methods issues and the successful integration of technology.

Modeling constructivist ideas in a teacher education program should be accomplished by both the instructor and students. The role of technology in modeling should include demonstrations by the instructor, integration of technology into daily activities and application of technology by students into class projects and field experiences. Examples might include demonstrations of exemplary packaged software for instructional or management use. The availability of technology for daily use is critical; thus, the establishment of technology classrooms as well as labs is essential. With technology classrooms, students would be able to work individually or in small groups at technology centers designed to enhance class activities and projects. Students should also be asked to integrate technology into demonstrations or lessons for the class and field experiences.

Reflection is another essential component of a constructivist teacher education program. Technology lends itself very favorably to individual and group reflection. Students should be asked to reflect often in class, individually, in small groups, and ultimately within the class as a whole. Word processing is an obvious method for reflection, but emerging technologies such as E-Mail, the internet, and blank databases are other arenas enabling reflection. Examples applying emerging technologies could ask students to send E-Mail messages to each other and to the instructor, as well as over internet, reflecting on various issues essential to preservice teacher education. Technology links between the university and the schools for sharing and reflection should also be a goal for teacher education. Again, this should be integrated as a daily, or at least weekly activity in teacher education programs.

Another necessary component of constructivist programs is active student involvement. It is essential that teacher education programs move from instructor-dominated modes to student-centered methods of instruction. The integration of technology on a daily basis facilitates active student involvement. Class activities should be project-based where students work individually or in cooperative groups to complete relevant activities. Examples might include research projects, lesson and unit planning, development of learning centers and other student-centered projects, and activities integrating management, Computer Aided Instruction (CAI), and multimedia software as well as emerging technologies. Cooperative learning activities where students are encouraged to use the computers to gather research, interact through E-Mail or the internet to acquire information or ask questions, and apply word processing, database, authoring, presentation, or multimedia programs would facilitate the integration of technology and constructivist ideas in teacher education.

Developing a community of learners is also a major component of constructivist programs. Although addressed in modeling, reflecting, and involving students actively, this is probably the key to a successful constructivist program and should be highlighted. Again, the integration of technology on a daily basis assists in the development of a community of learners. Technology labs and technology classrooms with computers available for a variety of uses including learning centers and cooperative learning facilitate this notion.

A model that has been developed that integrates technology and constructivist principles in teacher education programs is called "REMAKE IT." The title refers to the need for reform in teacher education, of which technology is a requisite component. The model can be adapted for use in preservice teacher education, inservice teacher education, or for teachers to use in the actual integration of educational technology into their teaching. It can also be applied to integrating technology in all academic areas. The model is intended as a guide only and should be adapted to individual needs. Each of the components of the model will be discussed in more detail following the list.

R- Review the basics of educational technology
E- Expose students to applications and possibilities
M- Model examples of lessons integrating technology
A- Apply technology to class activities
K- "Konstruct and konduct" (assignments, lessons & units)
E- Evaluate educational technology, applications, lessons

I- Initiate change - integrate educational technology
T- Teach others - facilitate systemic change

Students come into classrooms with a wide variety of knowledge and experience regarding technology. It is fundamentally necessary to determine students' knowledge and attitudes through surveys, pre-tests, or hands-on activities. Knowledge and attitude surveys and pretests have been developed by many school districts and state education agencies. Current research also includes survey instruments that may be of help in designing a form of assessment of knowledge and attitudes (Northrup and Rooze, 1990; Schmid, 1990; White, 1992). Through the use of cooperative learning, learning centers, hands-on applications, and review and overview lessons, students will be able to integrate technology in classroom activities. By truly integrating technology in all social studies curriculum units through the strategies mentioned above, students from a variety of technology backgrounds will develop necessary skills for successful use, thus "R" or "Reviewing" in the model will occur.

Students should then be exposed to the variety of possibilities and applications available through the use of technology. Demonstrations of various uses of educational technology including tutorials, games, simulations, word processing, data bases, spreadsheets, interactive multimedia, CD-ROM, publishing programs, presentation software, and authoring programs should be provided. The demonstrations should be student-centered with many hands-on opportunities, thus "E" or "Exposure" in the model will occur.

Following general demonstrations, technology applications should be integrated into actual lessons through modeling of specific examples appropriate to the curriculum. The modeling can be accomplished through individual, small group, or whole class lessons. Cooperative learning, inquiry, and learning center strategies are especially applicable for technology integration, thus facilitating the "M" or "Modeling" component.

Making the integration of technology in the classroom student-centered with students actively engaged in using technology is key. Therefore, students should be allowed the opportunities to use educational technology to complete assignments and develop projects and presentations, thus enhancing "A" or "Application" in the model.

A constructivist approach works well with technology applications. Piaget defined constructivism as a way of explaining how people come to know about their world (1969). Brooks and Brooks (1993) list the following as guiding principles of constructivism: posing problems of emerging relevance to students; structuring learning around primary concepts; seeking and valuing students' points of view; adapting curriculum to address students' suppositions; and assessing student learning in the context of teaching. Each of these principles is facilitated by thorough technology integration and helping with the "K" or "Konstruction" component of the model.

Opportunities must also be made for students to provide reactions regarding the use of educational technology and applications in schools. Students should be able to evaluate technology applications and debriefing/reflection sessions should be held which promotes the "E" or "Evaluation" component of the model.

The process of reviewing, exposing, modeling, applying, constructing, and evaluating involves students in the entire learning situation so that a change in attitudes regarding technology can occur. The real value of educational technology can be experienced by students who are able to apply technology in new situations. Students can become experts in various applications and are thus able to teach it to others. It is requisite that technology be integrated throughout the social studies curriculum and be used by the students during all units. These efforts will "Initiate" change and allow students to "Teach" others, the "I" and "T" aspects of the model.

The integration of technology is vital in teacher education; and is essential in a constructivist teacher education program. The major components of modeling, reflecting, involving students actively, and developing a community of learners will be facilitated through the use of technology. Applying a form of the model "REMAKE IT" will assist in a successful marriage of technology and constructivism in teacher education.

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Measuring Preservice Teacher's Information Literacy Skills: Implications

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Lenox and Walker (1994) proclaim that, "Clearly we can no longer expect students to learn all there is to know in any given content area. Rather they must develop the knowledge and skills needed to learn and relearn continuously" (p. 68). We agree wholeheartedly with this contention and believe that educational technology is a powerful tool to facilitate this process of learning and relearning. The technological trends in post-industrialized USA have implications for new literacies and competencies in teacher education as well as for effective citizenship. In our respective roles as a social studies educator and university librarian, we are particularly concerned with the essential competencies of the democratic citizen living in the United States and in the global village. Having agreed that information literacy and information competency are essential to the social studies, our intention is to foster these skills in social studies education. To implement this intention, we formed an interdisciplinary alliance between education and library sciences to address information needs for pre-service teachers enrolled in a methods course entitled "Teaching of Social Studies." Our partnership, which was previously described in this Annual (Slaughter, & Knupp, 1993), formally introduces elementary education majors to the concepts and benefits of information literacy with the goal of encouraging future teachers to pass on the appreciation to their students. We believe that current communications technology could benefit potential teachers and young learners in attaining greater knowledge and developing intellectual skills that are necessary to function effectively as citizens of the United States and in the "global village."

As one focus area of our partnership, we have been studying how preservice teachers react to the possibilities of using multimedia technology in their classrooms. Throughout our discussions, we use the term multimedia to mean integrated packages such as CD-ROM or interactive videodiscs. In our opinion multimedia is different from using "multiple-media" (in other words, incorporating the use of separate pieces of equipment in instruction such as a video player, camcorder, audio-cassette player/recorder, slide or film projector) to teach in the elementary classroom. We have introduced multimedia in the context of social studies education for two primary reasons. First, modeling the integration of technology in social studies classrooms not only motivates all types of learners but also promotes active learning and group problem-solving. Second, we wish to operationalize a philosophy that says no single textbook or basal series could satisfy the unique educational needs of the diverse learners who are in our elementary classrooms today. Therefore, our employment of multimedia is using it as a tool, in various ways, to provide opportunities for students having different interests to access, manipulate, and absorb information. One of the observations we have made from implementing multimedia in teacher education is that the combination of text, pictures, sound, color, motion, and video in a package which allows a user to direct how the information is presented, establishes a very powerful and flexible vehicle for creative teaching and learning.

Information Literacy

Information literacy is a much discussed concept in the teacher education and library literature today. A number of people have been involved with defining what information literacy is and how its concepts can be integrated into the teacher education curriculum. Behrens (1994) provides an excellent historical overview of the development of information literacy concepts. Despite the amount of work that has been done to define what information literacy is, very little has been published that focuses on measuring information literacy skills of pre-service educators.

The concept of information literacy employed in this study is taken from Doyle (1992) who defines it as an individual's ability to exhibit the following characteristics:

1. recognize a need for information
2. identify and locate appropriate information sources
3. know how to gain access to the information contained in those sources
4. evaluate the quality of information obtained
5. organize the information
6. use the information effectively

Background

This project took place at the Indiana University of Pennsylvania (IUP). This is a comprehensive regional university located in southwestern Pennsylvania with a broad range of undergraduate, masters, and doctoral level programs. IUP was founded in 1875, and has since grown to approximately 14,000 students. In Pennsylvania, IUP is the second largest institution that prepares teachers. The major education programs, Early Childhood and Elementary Education, are housed in the Department of Professional Studies in Education which has the largest number of students of any department on campus. The IUP libraries reflect the teacher training tradition of the institution by housing an extensive collection of education materials, including multimedia materials. The libraries, also, have adopted new technologies, such as an on-line catalog and CD-ROM databases to access these resources.

The Study

This study asks the question "What should educators know in order to integrate multimedia technology in the teacher education process that would enable preservice teachers to incorporate multimedia technology into their classrooms?" Before we introduced our students to the ideas of information literacy and multimedia, we conducted a short survey to determine what information literacy skills they already had and the extent of their exposure to information technology. We believed it would be instructive to educators to learn what students already knew and what place they held on the continuum of information literacy and information competency.

The survey was administered in-class prior to a scheduled library demonstration of multimedia technology and instruction with a focus of how to locate and access information for teaching social studies. After the librarian had introduced each group of students to the different social studies resources that were available, a follow-up multimedia learning activity was designed for gaining hands-on experience in the classroom. The hands-on experience involved small groups of two to three students working together to explore and discover various features of a multimedia electronic encyclopedia. Each group or team provided written feedback about features they used and included a specific comment about their team work. The following comment was made by one of the students, "It is so colorful and interesting. I think it could make any child want to learn. Children and adults would like it. It has many things to offer."

Two specific outcomes of the coursework were active learning and group problem-solving. It would appear from various comments, after the library instructional session and hands-on experience, that incorporating multimedia technology is one of the powerful tools which encourages learners to think.

The Social Studies Education/Information Literacy Survey

All of the sixty-one elementary education majors enrolled in "Teaching of Social Studies" responded in writing to 21 questions concerning their use of computer and multimedia technology. In addition, the pre-service teachers indicated the extent of their knowledge and skills in using print and non-print educational sources of information. The responses to 17 questions required a "Yes" or "No" answer to items dealing with students' awareness and hands-on experience using computers and communications technology such as: CD-ROM multimedia, FAX, e-mail, and the Internet.

The following table displays the fall 1994 results of the Information Literacy Survey for selected items:

Four of the survey questions focused on the students knowledge of various educational sources of information and required students to name an educational journal in each of the following designated categories: (1) scholarly, (2) practitioner, and (3) popular.

The Pre-service Teachers Profile

The students who responded to this survey were primarily female (80 percent) and seniors (87 percent) who had attended Pennsylvania public schools. More than two-thirds (67 percent) attended rural schools. Approximately 26 percent attended suburban schools, while 7 percent attended urban schools. All of the respondents were Caucasian and this is fairly typical for elementary classroom teachers.

Discussion

As found in Table 1, most students have used personal computers, printers, and floppy diskettes, probably in conjunction with word processing applications. However, responses indicate that while most pre-service teachers have had some exposure to computers and information technology, few have had experience with more computer-intensive tools such as CD-ROMs, videodiscs, and modems. Overall, the results show that most of the elementary education majors have had experience with the traditional "multiple" media tools such as video tapes, camcorders, audio-cassette tape recorders, overhead transparencies, and slide projectors. Also, the results show that pre-service teachers have had very little experience with computer communication tools such modems, electronic-mail, and Internet.

Table 1
Fall 1994 responses by preservice educators in percentages

Exposure to technology	YES	NO
1. Used computer in high school?	61	39
2. Used computer in college?	57	43
3. Presently taking a computer course?	11	89
4. Plan to take computer course before graduating?	33	67
5. Plan to take computer course after graduation?	44	56
6. Worked with computers as a student?	82	18
7. Used ERIC?	62	38
8. Used CD-ROM, CD-I or Interactive Video?	33	67
9. Used multi-media?	64	36
10. Worked with computers and multi-media?	52	48
11. Used telecommunications?	25	75

Familiarity with equipment	YES	NO
Have you used a(n):		
Personal computer	97	3
Printer	92	8
Floppy diskette	87	13
Word processing software	64	36
CD-ROM	18	82
Modem	21	79
Computer Databases	36	64
Videodisc	26	74
FAX machine	48	52
Video tape	97	3
Audio tape	90	10
Camera	95	5
Video camcorder	90	10
Slide projector	90	10
Transparencies	89	11
Overhead projector	89	11
E-mail	28	72
Familiar with Internet	21	79
Used Internet	5	95

Implications

Typically, teacher preparation programs require education majors to take a survey course in communications media. Therefore, the strong experience with traditional media tools is probably a direct result of this curriculum philosophy. In our respective roles as a teacher-educator and a librarian, we are acutely aware of the changing technological environment and resources as well as issues concerning educational equity and technology in post-industrialized United States. We believe that information literacy and information competency are essential for effective world citizenship. We have concluded from our survey results that a new curriculum philosophy that emphasizes resource-based learning and teaching might be appropriate for teacher education programs. This resource-based model for learning (Lenox & Walker, 1994) entails taking into account the changing resources of the real world and structuring partnerships between media specialists and classroom teachers to benefit learners in elementary classrooms. The results from this survey indicate that advances in communications technology are yet to be included in the communications media curriculum. An important question for teacher educators in light of these findings is: How aware are preservice teachers of the technological revolution in accessing information and are they using technological resources to participate in the interflow of information within and outside the United States?

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From Reel to Reality

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The growing apathy of teachers, preservice teachers, as well as the media, prompted the development of an interactive technology program focused on the Holocaust. The program was developed in the Education Department of Saint Mary's University, a small liberal arts college which is a participating member of the Center for Educational Development and Excellence (CEDE). CEDE's goal is the development of classroom teachers, school administrators, and teacher educators who can meet the educational needs of San Antonio's multi-cultural population, many of whom are considered "at-risk" of failure in the elementary and secondary schools. This collaborative was funded, through competitive grants, for 1.9 million dollars by the Texas Education Agency. A fraction of the money ($284,096) was received by St. Mary's University, now in the second year of this program.

CEDE's goals attempt to meet the call of the 1983 United States National Commission on Excellence in Education Report, *A Nation at Risk: The imperative for educational reform*. This report noted the need for support for higher education institutions to redesign educational programs to include the effective use of technology. CEDE provides training, support, and time to integrate technology in the classroom.

Current research (Topp, Thompson, & Schmidt, 1994) dealing with computer related technologies emphasized instructor modeling of integrative practices; yet also aware that this runs counter to what is actually happening in most educational settings. The instructor must become a catalyst who not only provides demonstrations but also encourages students to use technology as a tool and not as the focus of instruction. A goal was for students and teachers to become aware that technology has to become part of the planning and implementation of all elements of the curriculum.

Planning

To model this integration, an interactive program was developed to provide visual contact between two sites, a university classroom and a classroom in a middle school. The program also allowed opportunities for dialogue that would encourage a heightened cognitive awareness of personal contact that is not present with audio or audio-visual alone (Bauer, 1992).

The study included coordinated efforts by university faculty, preservice teachers, practicing teachers and administrators of partner schools. These schools have been identified as "unacceptable" by the Texas Education Agency for failing to meet state achievement standards. Selected middle and senior school "at-risk" students were chosen to participate, along with St. Mary's preservice teachers enrolled in SS 3300, in a combination course taught by Social Studies professors and an education professor.

The 50th anniversary of the Holocaust, a concurrent concern for the developing lack of knowledge of that significant historical period and an awareness of the current developments in Bosnia and the treatment of the Kurds alerted the social studies professor to a need. Building upon the interest developed throughout the population by Steven Spielberg's, *Schindler's List*, the education professor developed an interactive program. This was directed toward bringing historical reality within the grasp of students' perception — to bring reality to the real world.

Alter reported (1993) on the growing disbelief of people toward the actual occurrence of this catastrophic period. "In a survey of Americans, the Roper Organization found in spring, 1993 that 22% of respondents said it seemed 'possible' that the Nazi extermination of the Jews never happened. Another 12% "didn't know." Alter also stated that, "this explanation isn't so much anti-semitism as ignorance. More than 50% of the high school students didn't know what the word Holocaust meant. A quarter of all adults didn't even know that it was in Germany that the Nazis first came to power. As eyewitnesses pass on, the gap they leave must be filled."

The Sessions

To help fill this gap and prevent even further denial, if only in a small way, a three session program was developed with the generous cooperation of the Jewish Federation of San Antonio. The Federation provided a descriptive one hour film of the historical period from past World War I through the years citing situations that led to the rise in power of Hitler. This film was introduced by an elderly man who displayed his identification number tattooed on his arm. It was a significantand powerful introduction to that which followed.

Several days later a skilled trainer and a local public school teacher, further developed the film topics and answered questions from the audience. All questions were answered in a factual manner without any apparent biases. The interest of the audience was high; questions were many and varied. The trainer stayed beyond her allotted time to interact with the participants.

These two sessions served their purpose. They not only informed but further aroused the curiosity and interest in hearing the major speaker, a Holocaust survivor. The students were surprised to discover this was the man in the introductory film. To be certain, they checked the number on his arm. This survivor spoke of his years under Nazi domination, his period in the camps, the people who risked their lives to save him, and most of all his will and determination to survive. He led the audience through his personal revelations to an identification and empathy with other victims. Schindler's ghettos, yellow stars and badges, deportations, starvation, and torture developed new meanings. The magnitude of the extermination of six million made a tremendous impact. Yet, he spoke of the many acts of bravery, courage, and efforts of non-Jews to save the persecuted, showing some good amid the great evil. The speaker interacted with both groups of students, answering many questions that went beyond his initial speech. The middle school students hesitated at first but demonstrated an in-depth curiosity as they became accustomed to the interactive process.

These programs were shared with our partner school where students, teachers, and another St. Mary's professor participated in the program. A survey sample, is replicated in Table 1.

Table 1
Technology Survey: The Holocaust

5	4	3	2	1
High	Medium-High	Medium	Medium-Low	Low/None
Yes	High		Low	No

Using above scale note your answer and enter it on the line before each statement.

The first seven questions are directed toward your awareness of the topic before the sessions.

_____1. Previous knowledge of the Holocaust before program.
_____2. Seen the movie "Schindler's List" before program.
_____3. Aware of the memorial to the Holocaust in Washington, D.C. before program.
_____4. Aware of the current activities occurring across our country commemorating the 50th anniversary of the Holocaust.
_____5. Aware of program commemorating the Holocaust currently taking place at the Witte Museum.
_____6. Level of concern about occurrence of situations that might lead to other Holocausts.
_____7. Awareness of prejudice towards groups of people.
_____8. Previous participation in interactive conferencing.

The following questions required current awareness.

_____1. Current knowledge of the Holocaust.
_____2. Interest in visiting the Holocaust program at the Witte Museum.
_____3. Concern about the Holocaust after participating in the sessions.
_____4. Current level of concern about occurrences of situations that might lead to other Holocausts.
_____5. Will this program have you look at current events differently in the future?
_____6. Have you a heightened awareness of prejudice?
_____7. Do you have questions that have not been answered?
_____8. Would you like further information on this topic?
_____9. Is interactive video a way to get other information?
____10. Would you like to participate in other programs using interactive video?

Table 2 summarizes the results of the survey completed by college and middle school students. Means were computed for each item for each group. The results of a comparison of these means are included. These indicate that middle school students appeared to profit in all areas from the program. College students advanced their knowledge base in all areas but one — prejudice.

Table 2
Summary of Holocaust Survey Results

	Middle School	College	Diff.
Awareness before sessions:			
1. Previous knowledge of Holocaust	2.8	3.6	0.8
2. Seen the movie "Schindler's List" before program.	2.3	3.3	1.0
3. Aware of the memorial to the Holocaust in Washington, D.C. before program.	1.7	3.0	1.3
4. Aware of current activities occurring across our country commemorating the 50th anniversary of theHolocaust.	1.7	2.5	0.8
5.Aware of program commemorating the Holocaust currently taking place of Witte Museum.	2.2	3.4	1.2
6. Level of concern about occurrence of situations that might lead to other Holocausts.	3.2	4.2	1.0
7. Awareness of prejudice towards groups of people.	2.8	4.8	1.9
8. Previous participation in interactive conferencing.	1.8	2.5	0.7
Current awareness:			
1. Current knowledge of Holocaust.	4.0	4.3	0.3
2. Interest in visiting the Holocaust program at the Witte Museum.	4.6	4.6	0
3. Concern about the Holocaust after participating the sessions.	4.2	4.3	0.1
4. Current level of concern about occurrences of situations that might lead to other Holocausts.	3.3	4.4	1.1
5. Will this program have you look at current events differently in the future?	4.1	4.4	0.3
6. Heightened awareness of prejudice.	3.9	4.2	0.3
7. Do you have questions that have not been answered?	4.8	3.3	-1.5
8. Would you like further information on this topic?	4.6	3.6	-1.0
9. Is interactive video a way to get other information?	5.0	4.8	0.2
10. Would you like to participate in other programs using interactive video?	4.5	5.0	0.5

Conclusions

A pre and post test comparison of both groups can be viewed in Table 3. All areas noted gains but one, college level prejudice. This difference was slight, only a drop of 0.1. It should be emphasized that both groups indicated the highest scores on the post-program section that dealt with future interactive participation.

More significant than the numbers generated by the survey was the comment made by a teacher who assisted with the public school segment of the program. She said that the students felt special because they were chosen to work with people from St. Mary's. We know that many at-risk students never reach their potential (Poerft & Canales, 1993). Cultural differences, language barriers, handicaps, and socioeconomic status affect their lives. Meaningful experiences, appropriately applied in the mainstream of instruction with all diverse populations, might be one of the answers to raising literacy.

Table 3
Summary of Mean Scores - Select Items

1. Awareness of Holocaust		
Previous knowledge of Holocaust	2.8	3.6
Current knowledge of Holocaust	4.0	4.3
Gain/Loss	1.2	0.7
2. Witte Museum Program		
Awareness of Program	2.2	3.4
Interest in visiting programs	4.6	4.6
Gain/Loss	2.4	1.2
Pre Reoccurrence of Holocaust		
Pre-program of concern	3.2	4.2
Post program level of concern	4.2	4.3
Gain/Loss	1.0	0.1
Prejudice		
Pre-program level of awareness of prejudice	2.9	4.8
Post program level of awareness of prejudice	3.9	4.2
Gain/Loss	1.0	-0.6
Interactive Participation		
Pre-program interest	1.8	2.5
Post program interest	4.5	5.0
Gain/Loss	2.7	2.5

This study appears to have raised the awareness level of participating students of a dark period in world's history. However, the teachers need more follow-up activities to keep that small spark alive. On our part, St. Mary's is currently planning two further interactive programs, one in science and another in literature. The coming year is certain to show progress — small but ever growing. The hope is that one small spark will generate many others.

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Lecture in Teacher Education: A Renewed Point of View

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During the last six years, a group of researchers and teachers in sociology, pedagogy, philosophy and youth research have organised a multidisciplinary lecture on the modern embodiment (body) for the students of physical education at the University of Jyväskylä, Finland. The purpose of the lecture has been to deepen the students' knowledge and experiences of the human body in school, everyday life and in sports (eg. body as a machine/tool vs. as a core of personal identity). Subsequently this lecture has become part of the research actitivities on teacher education of the Department of Physical Education (eg. Silvennoinen, 1992, 1993; Piispanen 1993).

This article discusses lecture 1) as part of current teacher education and 2) as a vehicle in fostering active learning in physical education students.

The Lost Halo of the School and Teacher Education

The Geman educator Thomas Ziehe has written extensively on the changed position of the school especially in Germany. In his opinion, since the 1970's the school has been losing some of its former social relevance in the eyes of the pupils. It has lost its traditional 'aura' and it has become just one place among many other 'places' such as the media, leisure institutions, friends, consumption (Ziehe, 1991,p.167).

The old school could be characterised "as production units rather similar to factories, with tayloristic teaching practices defining the boundaries of teaching and learning in a narrow didactics based on discrete subject areas, without leaving much latitude for teachers, not to mention pupils" (Miettinen, 1989, p. 6-7).

This no longer applies. Even if the degrees of freedom in school-based activities are now much higher, the teacher counts only when he/she can really do something. Teachers no longer can take themselves for granted based on their role. Even when children enter the school they possess various special competencies (eg. sports skills, role games, computer literacy), which teachers have to acquire at a mature age - if that is feasible at all. "Thus the teacher needs to create the symbolic meaning of the school on a daily basis - and this makes his/her job particularly stressful." (Ziehe, 1991, p.168).

"Anything can happen" - inside the school and outside it. This is a familiar feeling that Ziehe has called 'modernity' . "Modernity is a condition in which the multiple levels of meaning have become a problem of our everyday life. Accordingly, every educational situation now involves several levels - functional, symbolic and imaginary - and these levels by no means always coincide." (Sironen, 1992).

According to Baethge (1989, p. 32-33), "the changes in the living conditions and identity formation of the young manifest a shift from productive socialization in the workplace and the family to 'consumerist' socialization in educational institutions and leisure time. Consumption has become an important part of identity formation." Ziehe (1991, p. 118-122) argues that the opportunities opened up by the new situation lie in the increasing reflexivity, malleability and individualization of identity models.

"The esteem of school always depends on the social interpretations, identity needs and psychodynamics of different social groups. The more the taken-for-grantedness of the classical intergenerational relations and stable identity models dissolves, the more the school loses its cultural halo in the eyes of the parties concerned. Therefore, the tasks of education and schooling and their relationship to modern youth should be considered from the point of view of cultural modernity and the instability of labour market". (Ziehe, 1991, p. 167). "Applied to the school, the theory of modernity helps one to recognize the multiple realities prevailing in the classroom. The 'covert curriculum', as we all know, is one of them, but by no means the only one". (Sironen, 1992).

Today researchers in social sciences speak more about life style orientation than about living standards. The component of life style orientations of particular interest Ziehe (1994) is self-attention. As Schulze (1992, p. 53) argues, the shift in attention to self-stages finally implies self-observation. "An unavoidable element of reflexivity is contained in the level of expectation that aims for 'good' self-states. Life styles are an expression of an orientation pressure which has turned inwards. The new questions are 'What do I actually want?' and 'wWhat matters to me?'.

Several Finnish studies of teacher education have shown that teacher candidates regard their training as too fragmented (eg. Rantakari & Tiainen, 1983; Uusikylä, 1983). Such fragmentation cannot, however, be corrected by attending to the visible curriculum alone . Behind such feelings of fragmentation there is often a more general problem, possibly a wish to be able to work on one's own (teacher) identity (Silvennoinen, 1992). Students tend to suspect that the school is not very much like the image that they acquire during teacher education and practice teaching, and begin to feel that it is, for the most part, something else and something more (Denscombe, 1982).

Lecture and New Reflexivity

Learning has been characterized as surface learning or deep learning. "Students can adopt either a deep or a surface approach to their reading ... and many other learning tasks - in lectures, essay-writing and problem-solving" (Entwistle, 1990). "A deep approach draws on a sophisticated conception of learning with an intention to reach a personal understanding of a material presented. To do this, the student has to interact critically with the content, relating it to previous knowledge and experience" (Entwistle, 1980). At its most intimate, a lecture can facilitate reflexivity, ie. sensitivity towards reflecting on one's environment and on oneself, which are clearly important domains of one's own (teacher) identity.

Modernization, to which the school is intrexicably bound, manifests itself in two ways: as system functionalization (increase in machinery and in regulation) and on the symbolic level, which makes possible the subjectivization of self and world interpretation among the pupils (and teachers). It is a question of a new type of reflexivity: the undermining of self-evident 'truths' and indvidualization. The latter may mean a general expectation that everyone must manage 'on one's own' in life ("I **must be** myself"), and in expressions such as autobiographical self-interpretation ("I must be **myself**"), symbolic self-determination ("I - among others - want to be **different**") and interindividual self-requirement ("I want - through acceptance by others - **realize** myself") (Ziehe, 1992).

In physical education the body is typically taken for granted. It is seldom examined from any other angle than that of a performing, skilled and trained body in spite of the fact that it is full of civilisatory norms and semiotic signs. In his/her future work, the teacher is always face-to-face also with these social messages of the body at the same time as his/her body is the object of pupils' eyes (Silvennoinen, 1992).

Related to the theme of this article, it was obvious that PE students' education lacked a topic which would compel the students to make interpretations of their cultural environment and its changes (reflexivity). One possible study unit for PE teacher education students would be 'modern embodiment and youth' - realized specifically in a lecture form, but not in a traditional manner. 'Non-traditional' lecturing has meant a 'challenging' manner of presentation. In a way, students have been forced to take a stand, for instance, about their own school experiences. Topics have been addressed through discussion rather than primarily through one-sided communication from the teacher to the student. At regular intervals, two teachers have faced the class. In a panel-like situation one teacher has been able to comment on what the other teacher has said, and both have been able to respond to students' questions. Teacher talk has been complemented with photographs, audio and video materials. The 'review' of lectures has taken the form of student logs and 'homework essays' on an interesting topic. Students have also assessed how interesting and useful the lectures have been (Silvennoinen, 1992).

Lecture Takes on a New Life

In the spring of 1994, when the lecture series was over, the students wrote essays at home on their personal experience of eg. maleness (mascunilinity) and femaleness (femininity). The intention was to find out what kind of representations of masculinity/femininity (bodily ideals and reflections) future PE teachers have. The essays were written by 3rd-year students (N=123). Despite the fact that writing was optional 106 students seized the pen, 61 women and 45 men. About 300 pages of text was obtained.

At the back of this kind of recollection task was the idea that an autobiographical handle on oneself (eg. Ziehe's self-interpretation) - in this case related to experiences and myths of masculinity-femininity - are both experiential and linguistic metaphors which portray and create reality. In this sense no knowledge concerning a person is absolute but, in fact, is multi-faceted and context-bound (Bain, 1990). Persons writing about themselves, as it were, assess their own lives or activity in retrospect by contructing a narrative story of identity (Nurmi, 1994).

Reconstruction

Tomboy is probably the most distinct special charactetistic of female physical education students. Some research even suggests these women, many of whom have been 'daddy's girls" and in childhood even wanted to be boys, are clearly 'action makers', not those who just note that things are happening to them (Eichler, 1991, p. 146). They are (or have been) active athletes, even in traditional male events (football, ice-hockey, heavy athletics).

Men appear to feel uncomfortable about women who are seen too masculine (Silvennoinen, 1993). Several writers thought that there have to be some limits that women should not cross. A woman should not lose her 'femininity', either, on account of sport (looks, sexiness, etc). At least in his respect the future male teachers needs to take another look at themselves, because the 'classical male role' is not very credible. On the other hand, in Finnish school physical education, where boys and girls are taught separately, it is possible to strenghten rigid role models and images.

Whereas several women move in 'either-sex' domains, there are few cases where men cross over to areas felt to be feminine. The counterpart of tomboy - *sissy* - is taken as an insult rather than as an acceptable way of trying out things typically attributed to females in a culture. Thus it appears that future female PE teachers feel that androgyny gives them something extra while men are afraid to lose something through it.

Quite a few of the end-of-course essays described expriences of change that were more than usual descriptions of a transition from childhood to adulthood through growing and getting more 'sense' - in other words, fragments of 'identity work' (Ziehe, 1992). In this respect especially tomboys' writings appeared the most varied - perhaps just because of that non-fixed role image. Men did not frequently display reflections on personal crises or difficulties. The masculine world of sport had probably given them such a strong anchorage that not even the father's role as a target of identification emerged as strongly as among women.

Conclusions

Qualitative methodologies adaptable for either traditional anthropology or interpretive ethnography are not new in the studies concerning teacher education. However, they represent in Wexler's (1987, p.36) words "the new sociology of education, which aims to analyze social knowledge in schooling and social knowledge about schooling as relative, socially determined and ideological. Besides, using hermeneutics it is possible to trace different power structures and meanings to the gender." This point of view is similar with the study made by Duncan and Hasbrook (Schempp, 1990) which indicated how sport, in its dialectical relationship to a wider culture, perpetuates the denial of power to women in society.

Life histories (autobiographical texts) provide an excellent vehichle for recording and interpreting the students' voices - in their own terms, in ways that give meaning and belonging in their life. The students may recognize that their identity as a teacher can not be based any more on stiff dichotomies which make a clear-cut difference between the 'men's and women's affairs. They may realize that their work as a teacher today demands more capability to encounter variety, ambivalency and uncertainty than fixed curricula and didactics. Students' texts and comments indicated that lecture themes led them to a process (writing) which could be called 'memory work' (Haug, 1983). Through their texts they also produced research material which at a later date will return to their hands in the form of publications and teaching materials. Obviously, not all texts were very 'deep' but this kind of self-thematization through lecture stimuli was new in an interesting manner: 'This was my story, what is yours?'

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Implementing Computer Technology in a Teaching Methods Class

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Research has shown that all schools in the United States today own computers for instructional purpose and thousands of educational software packages have become available for teachers and students to use (Kinnaman, 1990; ASCD, 1990). Word processors, such as Word Perfect, and electronic mail (E–Mail) are commonly available. However, while the distribution of computer resources has remarkablely improved in schools, using it to improve the learning environment has not (Electronic Learning, 1993). While there is an emphasis in many school districts on inservice training, pre–service teachers need to be prepared to use technology in their classes, and a teaching methods class can be vehicle for that preparation.

At Kennesaw State College a general teaching methods course is offered for the education majors who have been admitted to the teacher certification program. The content of the 2-credit course, which is taught in the same semester as content-specific methods courses, is based on the common subject matter all students should learn, regardless of the subject they will teach, and it serves as perparation for the field experience that is required during the junior year. Students attend the course for 2–hours a week for ten weeks and explore teaching and learning theories, design unit and lesson plans, practice questioning techniques and teaching strategies, and discuss classroom management and assessment skills. After ten weeks, students are placed in school settings for on–site classroom teaching practice. With only twenty contact hours, and a full schedule of topics to cover, the challenge of including coverage of technology is significant.

I have used a triangle model of technology integration with each side of the triangle representing a type of technology: word processing, electronic mail, and a content–related courseware. Word Processing provides opportunities for keeping learning journals and writing practice. E–Mail offers convenience for communication between students and instructor, students and students. The content–related courseware reinforces students' reading and content learning. Therefore, the discussion and sharing in the teaching methods class becomes much more meaningful, efficient, and practical. With this triangle implementation model, facilitated learning occurs through hands–on learning activities with computers.

Word Processing

The first component of the triangle model is word processing. According to Heinich, Molenda and Russell (1993), instruction is the arrangement of information and environment to facilitate learning, and learning is the development of new knowledge, skills, or attitudes when the individual interacts with information and environment. The design and arrangement of instruction has a great deal to do not only with what is learned but also with how the learner uses what learned. Assignments that involved word processing, and training provided by the instructor on word processing fundamentals, helped students acquire a basic proficiency. The instructor spent about a half hour of classroom time helping students learn the basics of Word Perfect including starting the program, saving and loading files, and editing and formatting text. After the basic training, students learned Word Perfect through assignments such as keeping their learning journals, designing lesson plans, and completing paper writing assignments.

Electronic Mail

Another component of the triangle model is E–Mail. E–mail between students, using accounts set up on the university computer system, helped them ask for and get help from each other. After the introduction of e-mail, electronic communication from student to student as well as instructor and students was frequent. E–mail helped create a realistic cooperative learning atmosphere. In my experience adding e-mail helped create an environment that supported both creativity and cognitive flexibility, and students became more task oriented and had more pleasure in learning, something that is predicted by Stipek (1993).

Content-related Courseware

The third component of the triangle model was content–related courseware. For the purpose of reinforcing students' knowledge of course content and to encourage students to learn with computers, the instructor designed drill and practice courseware. With the courseware students set their own learning paces, reinforced their own learning, and used the computer for learning. In the first week of the class, the instructor discussed and demonstrated for students how to run the computer courseware. Use of the course-related instructional software helped students learn some basic computer literacy skills as well as topics in learning theory and selecting educational software. Students also read the course textbook and current journal articles outside of the classroom, learned with the aid of computers at their own instructional pace, and participated in meaningful discussions and creative sharing within the limited classroom meetings.

The courseware has two major strengths: it was content–related and it was easy to use. The first strength of the courseware is that its contents are closely related to the textbook. It is developed on the basis of the textbook and the authors' instructional menu. The textbook, *Methods for Teaching: A Skill Approach* (Jacobsen, Eggen, Kauchak, 1993), consists of three units with 11 chapters, covering the contents of three phases of teaching— planning, implementing and evaluating. In authors' words, "these planning, implementing, and evaluating components represent a continual process in which professional teachers strive to increase the quality of their instruction, that is, facilitate learning in increased numbers of students." The content–related courseware consists of eleven drill and practice exercises which are closely matched with the chapters of the textbook:

The eleven topics of the content–related coursware include:

. A model for teaching
. The goals of instruction
. Goals and Objectives
. The affective, psychomotor, and cognitive domains
. Unit and lesson planning
. Questioning skills
. Teaching strategies
. Accommodating learner differences: Instructional strategies
. Classroom management: Prevention
. Classroom management: Intervention
. Measurement and evaluating

In the methods class, students can read the textbook, reinforce learning through drill and practice with multiple choice exercises at computers, and bring the experience and questions to the class for sharing and discussion.

The other strength of this courseware is very easy to use. Students only need to type *START* at the DOS prompt to run the program and they can quit the drills at any time. Students can select a topic and the courseware provides students practice with multiple choice exercises which are directly related to their own reading. With each multiple choice exercise, students can try three times to select a correct answer. Every time he or she gets the correct answer to the question, positive comments, such as "Great job" and "Wonderful", are displayed. If the student fails to answer the question within three trials, courseware automatically offers the correct answer. It gives students the opportunity to experience firsthand the effects of the computer–assisted instruction they might adopt into their classroom. The courseware also keeps track of each student's performance. A report card at the end of each practice provides the individual student detailed information of mastery.

Implement of Multimedia: Possibilities and Suggestions

Multimedia, the integration of text, graphics, audio, video and other types of information, is now affordable for schools. It is also a likely candidate for indclusion in a methods course. *HyperStudio*, a multimedia authoring tool, could be used as a multimedia presentation tool and would thus be a potential candidate for inclusion in the methods course. In a methods course HyperStudio could be *taught about* and it could be used to study other content in the course (*teach with*).

The procedures of implementation with HyperStudio could include:

1. Introduce HyperStudio and help students create multimedia learning portfolio.
2. Require students to create multimedia presentations on course content using HyperStudio.
3. Involve students in a lesson plan cycle that includes planning, implementing, and evaluation and require that some material for the lesson be created with HyperStudio. Students could analyze their learners, develop clear objectives, select and create appropriate multimedia products, integrate the multimedia materials into the lesson, involve learner's in the lesson activities, and evaluate the effectiveness of the lesson. The material developed by students using HyperStudio would, of course, be placed in their portfolio.

Of Course, *HyperStudio* by no means is a sole and perfect multimedia authoring tool for the teaching methods class. For an intermediate level multimedia user, *Astound* might be recommended, and for an advanced level multimedia user, *Authorware* could be considered.

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THE COURSE

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The Educational Computing Course

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The articles in this section look at various aspects of preparing preservice teachers to use technology in teaching, learning, and classroom management. The authors represent schools of education in Texas, Florida, Massachusetts, Montana, and New Mexico. The reader will notice a consensus of attention to curriculum integration, critical thinking, and problem-solving. It appears that once a certain technology-teaching comfort level is reached by faculty, course development efforts can focus on subject-matter and instructional theory within these courses.

Higdon (University of Texas at Austin) offers a heavily documented historical evolution of computer literacy for preservice teachers. She concludes that application management, software evaluation, resource management, networking and software development are the focus in today's preservice, technology education.

Cook and Cimikowski (Montana State University) describe their required preservice technology course which has undergone major restructuring. It now features self-directed, student-centered experiences through the hands-on use of technology and the implementation of cooperative learning strategies.

Raiford and Braulick (University of Texas at Austin) present a course in which preservice teachers work collaboratively to produce eleven, required, mini-projects using word processors, spreadsheets, databases, HyperCard, Internet, Print Shop, and Logo. Most significant is that all assignments are specific and pragmatic; some relate to classroom management, others to student productivity. This course provides preservice teachers with a broad, multifaceted introduction to technology.

Collier and McDevitt (University of Massachusetts at Lowell) present a more in-depth view of first experience in which each preservice teacher, as part of a cooperative group, masters one of four technologies: Concept mapping using Inspiration, CD-ROM and Laserdisk-based instructional software, multimedia production using Action, or Mosaic-based data communications on the Internet.

Burson (University of Houston) describes two field-based courses developed to support PUMA, a model curriculum in which prospective teachers are expected to use technology to organize class notes, obtain content-appropriate technology resources, maintain grades and records, and develop other applications related to teacher productivity. Also at the University of Houston, Wright and Zhang present research about preservice teachers' attitudes toward computer use collected during the courses described by Burson.

Willis (University of New Mexico) describes the required preservice technology course as one which presents computer technology in a problem-solving interdisciplinary environment, in which technology is the vehicle that drives the content.

Flake and Molina (Florida State University) propose, for group discussion, a technology-infused methods course in social studies that would serve as a model for other methods courses. The learning environment proposed features multimedia and telecommunications in the learning process. They discuss a restructured role for the classroom teacher and the advantages to be accrued from student use of technology-based simulations.

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The Evolution of Computer Literacy for Preservice Teachers

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The definition of computer literacy has evolved since the 1970s when it was defined as knowledge and understanding of computer hardware and software. Since then, computer literacy has assumed a more applications-oriented definition. Today's literacy encompasses enhanced learning across content areas, hypermedia, multimedia, and telecommunications. This paper traces the evolution through literature and course offerings.

Computer Literacy: The original definitions

In its beginnings, computer literacy addressed an understanding of hardware and software development. The student was expected to know the parts of the computer, (i.e., central processing unit, keyboard, motherboard, external hard drive, monitor, printer, etc.) both internal and external. A comprehension of the internal workings of the computer was considered just as important to know and understand as the writing of code for programming the computer. The student was required to become conversant in programming languages since it was necessary to know the language to get the computer to do many required actions. Therefore, students were computer literate if they were knowledgeable about hardware and software.

Programming was a major part of computer users' requisite skills. BASIC was the most widespread programming language taught to students of the computer. This knowledge was rudimentary until application programs were developed which allowed the computer user to work on the computer without first constructing a program to make the computer do whatever function was needed. The seventies into the early eighties saw a vast improvement in software development which changed the focus of the computer user from programming to application utilization (Dershimer & Dershimer, 1991).

Computer Literacy: An Applications Orientation

The early 1980s witnessed the development of personal computers and software for management purposes. Word processing, spreadsheet, and database application programs became widespread in business and emerged in the educational scene as productivity tools for the learning process. A definitive reexamination of what constituted computer literacy was sparked in the mid-eighties. Movement away from insistence on hardware knowledge and development and toward an awareness of computer hardware was a major step from the computer scientist and towards the computer educator. Kelman (1984) looked at an emerging "general consensus that computer literacy involves two major thrusts: 'computer awareness' and the ability to do computing, most often meaning programming in BASIC." Other members of the professional field were just as involved with a reexamination of computer literacy and its needs for the educator (Johnson, Anderson, Hansen & Klassen, 1980; Lueherman, 1981; Watt, 1981). Definitions varied:

> Computer literacy means, you have to understand what a computer is and what makes it do what it does...you must be able to communicate with it (Luehermann, 1982).

Computer literacy is a familiarity with a device that enhances one's ability to live in and cope with the modern world....the ability to manipulate computer technology (Scher, 1984).

Computer literacy is the skills and knowledge needed by all citizens to survive and thrive in a society that is dependent on technology of handling information and solving complex problems (Hunter, 1983).

Computer literacy is a working knowledge of computers (Moursuand, 1982).

I think of computer literacy as a cultural phenomenon which includes the full range of skills, knowledge, understandings, values, and relationships of a computer-based society (Watt, 1982).

A computer literate person is one who understands how computers work and the role of computers in society, and who can use the computer comfortably (Richman, 1982).

The debate raged on, with more emphasis being placed on *how to work the computer*, rather than how the computer worked. Teacher education programs began teaching applications programs (OERI, 1986; Poirot, Taylor, & Powell, 1987, Bitter & Yohe, 1989). Word processing, spreadsheet and database programs were added to the curriculum and hardware construction knowledge was deemphasized (OTA, 1988). Software evaluation was also considered important for preservice teachers (Miller, 1987). Computer literacy was now being defined as "being able to manipulate the computer through computer applications" (Baumlin & Cone, 1985; Black, 1987). Programming was still important, but was no longer of primary importance. Computer literacy now consisted of application management, some BASIC programming, and an awareness of computer parts (mostly external, e.g., CPU, monitor, keyboard, printer, mouse). By mid-decade, technology in the training of preservice teachers had become an important consideration.

Computer Literacy in the Content Areas

Many preservice teachers were becoming efficient in the use of applications programs and in software evaluation, as part of their undergraduate courses of study. However, computers were not being utilized as teaching tools (Stieglitz & Costa, 1988). This realization led to another reexamination of computer literacy for preservice teachers. Emphasis on how to use computers in teaching mathematics, science, English, social studies and other disciplines became the focus for educators across the nation (Beall, 1984; Dickey & Kherlopian, 1987; AAAS, 1989; Borkowski, Schneider, Pressley, 1989; Selfe, Rodriques, and Oates, 1989; Ellis & Kuerbis, 1991; Kearsley & Lynch, 1993). The discussion on how to use computers in the content areas began in earnest in the mid-eighties (Beall, 1984), proceeded through the late eighties (Ayers and Bitter, 1988; Pressley, 1989) and has proved to be a hot topic in the nineties (Selfe, C.L., 1990; Arnow, 1991; Meyer, 1991; Bitter and Yohe, 1992; Boone and Gabel, 1994). The primary content areas included science (Bitter and Yohe, 1992) and mathematics (Meyer, 1991). But computer integration also occurred in social studies (White,1991), English (Selfe, 1990) and elementary preservice activities (Boone and Gabel, 1994). With the advent of CD-ROM and laserdisc databases, and hypermedia computer integration in the content areas, preservice computer literacy studies have moved from programming languages into authoring programs for content development.

Computer Literacy: From Programming to Hypermedia

With the availability of hypermedia languages for education such as HyperCard, Linkway, and Toolbook, the preservice teacher could learn to develop software targeted for a specific content area with little difficulty. The necessity of learning programming languages such as BASIC, FORTRAN, or C+ to develop software was diminished. The new authoring systems did not restrict the programmer to linear progression; it was now possible to "hypermove" or jump from one area of the program to another and back. By the nineties, these authoring programs were being espoused and taught in college courses (Munday, Windham, Stamper, 1991). Once again, evolution to a new level of computer literacy had occurred in preservice teacher education.

Computer Literacy: Telecommunications

Another evolutionary change in computer literacy accompanied the move from stand-along computing to networked communications. The Information Super Highway was waiting to be discovered and explored. The technology pioneers of this decade ushered in the use of telecommunications in the classroom, necessitating the need to teach telecommunications in preservice education (Kearsley and Lynch, 1992). A modem, a computer, and a telephone line open the preservice teacher to the world which is rich in resources and contacts (Bull, Harris, Lloyd, and Short, 1989; Casey, 1991). E-mail and online databases available via Internet increase the skills which preservice teachers should acquire (Schrum, 1992). Sending and receiving e-mail, networking with other professionals, telneting, file-transfer-protocol, downloading, uploading and gophering are new terms which reflect the skills allowing teachers to "surf the Internet". Research online by kids in the classroom (Schrum, 1989), resource searching (Addison, 1994) conferencing (Eskridge and Langer, 1993), and networking locally, nationally and globally (Anderson, Perry, and Schimdt, 1993) have added new skills which now define the computer literate preservice teacher. These skills enhance the teacher as a facilitator of knowledge rather than the fountain of all wisdom. Electronic communication via the Information Super Highway again has moved computer literacy another notch in the evolutionary progression. The future evolution of computer literacy encompasses these skills plus the reorganization and extension of basic computing, programming, software evaluation, telecommunications and hypermedia development and use.

Computer Literacy: Multimedia

Multimedia for many preservice teachers today involves the use of HyperCard, Linkway, Authorware, or other comparable tool, and a CD-ROM or laserdisc. Ubiquitous multimedia instruction for preservice teachers will probably be the next step in computer literacy evolution. At this writing, some colleges of education are introducing their preservice teachers to the wonders of multimedia (Vess & Alexander, 1993). Multimedia can be anything from a computer and a CD-ROM disc to a full-fledged program utilizing hypermedia, video, sound, interactivity for the user, and online telecommunications. This new area of computer literacy is exciting and vibrant. Computers are now being sold as "multimedia computers" indicating that business recognizes multimedia as a successful teaching tool (Marcus, Nicholson, and Phillips, 1991). Just as authoring tools are now being taught to preservice teachers for content specific software development, multimedia development shall become an accepted part of the preservice teacher's computer literacy skills.

Conclusion

To paraphrase the cigarette commercials of a decade ago, "You've come a long way, baby!" Computer literacy has come a long way. Computer hardware and software development is still a priority, but the use of the computer is of more primary importance for the preservice teacher. Application management, software evaluation, resource management, networking and personal interaction plus software development (programming) are the focus in today's preservice education. How to use the computer tools available encompasses knowledge and understanding of word processing, spreadsheets, databases, telecommunications, hypermedia, and multimedia (in the immediate future). As our computers themselves have evolved into powerful educational tools, so too, has our preservice education evolved in the area of computer literacy. This evolutionary process is never ending. Just as we are always learning and growing, so too must our preparation of tomorrow's teachers expand in relation to the demands of the future.

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Needed for Students: More TLC (Technology and Learning Cooperatively)

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As technology continues to infiltrate every nook and cranny of civilization at an increasing rate, the teachers who instruct others how to use this rapidly-developing technology (and, in fact, teachers in any discipline) must learn to utilize advanced technology and effective teaching/learning strategies in their own teaching methodology. Teachers can only impress students with the importance and effectiveness of using technology and a variety of teaching/learning strategies if they act as models. Hypermedia, presentation technologies, newsgroups, and telecommunications are only a few of the many technologies now available to the instructor to metamorphose the traditional lecture into a kaleidoscope of student-centered, student-controlled activities. Cooperative learning is an excellent example of an effective learning strategy that can be used in conjunction with these technologies to enhance the learning process of students, whether they are learning to use a particular technology, integrate software, or write an English paper.

TLC: Technology and Learning Cooperatively

EDCI320, Foundations of Instructional Computing, is a class required in the Education Department of Montana State University where teachers and preservice teachers learn to use computers and associated technology for accessing information, to communicate through the Internet, to develop computer related teaching tools and materials, to enhance instruction by evaluating and integrating appropriate educational software, and to understand ethical issues related to educational computing. The instructors of EDCI320 initiated a project entitled TLC, Technology and Learning Cooperatively, to change the basic structure of the class. Project TLC, funded by the Montana State University Instructional Development Grant Program, proposed that EDCI320, which was taught using a traditional one-hour lecture and a two-hour hands-on lab weekly, become a more self-directed, student-centered experience through the employment of technology and the implementation of cooperative learning strategies.

HIP (HyperCard Information Program)

The TLC project proposed that the information typically taught in lecture (e.g. history of computing, teaching and learning theory, and telecommunications) be incorporated into a HyperCard Information Program (HIP). HyperCard, a Macintosh authoring program, incorporates text, graphics, sound, and the capability to execute nonlinear branching. Students access material normally taught in the lecture by choosing an objective in the HIP table of contents. From this beginning they may be able to branch in whichever direction their interest and curiosity takes them, proceed at a comfortable speed, and repeat any material they desire. This is a radically different way than lecture for students to learn material and reduces intellectual passivity and linear thinking. Also, as students learn HyperCard basics later in the course having actually seen and used HyperCard should be of benefit when they began developing their own HyperCard stacks. Student evaluation of the use of HIP stacks to access information normally presented in the lecture mode indicated an acceptance of this method and was positive overall. Students especially liked the fact that they could access the information at a time that was convenient to them and at the speed that they desired.

Cooperative Learning in Lecture

Once the information that was typically "poured and stored" into the student during lecture had been incorporated into HyperCard stacks, cooperative learning was introduced into the lecture hour. The cooperative learning required of students a more active, analytical role and encouraged them to take greater responsibility for their own learning. Instead of sitting passively at their desks taking notes during lecture, the students spend time thinking, synthesizing information, and applying ideas.

Students were divided into home teams of four or five students (initially by random selection and then grouped by area of interest). They were then taught interpersonal and shared leadership skills, necessary for successful cooperative learning groups. Each team participated in a series of cooperative activities designed to lead them to discovery and evaluation of information. Group members were encouraged to support each other by teaching, sharing, questioning, encouraging, and praising. Each new form of cooperative learning used for each activity (e.g. jigsaw, base groups, focused discussion pairs, peer editing [Johnson, Johnson, & Smith, 1991, 4:17-4:19, 5:13]) was modeled and explained to the students so that they could use the teaching technique on their own.

Active learning was used if material had to be delivered by lecture. The actual lecture portions usually lasted only 10-15 minutes. The information was typically delivered using PowerPoint presentation software, a computer, LCD panel, and overhead projector. Focused discussions were held before and after the lecture with interspersed pair discussion during the lecture. During interspersed pair discussion, students divided into pairs or small groups with instructions to respond in the following way to formulate his/her own answer, share that answer with the group, listen carefully to each member explain his/her answer, and then create a new group answer, hopefully better than any single answer which builds on each person's thoughts (Johnson, Johnson, & Smith, 1991, 5:10-5:13). To stress individual accountability, a member of each group was randomly selected to present a brief summary of that group's decisions.

The jigsaw was used to replace the lectures on history, hardware, memory, and "hot topics" in computer education. This method was chosen to encourage individual accountability and motivation, provide students with an opportunity to teach, increase sharing and communication, and provide students with opportunities to use technology.

The first jigsaw task was to break the unit into parts and have each group member select a part to research and teach to his/her fellow group members. Each group member was then given a set of topics corresponding to the part to be researched (Johnson, Johnson, & Smith, 1991, 4:17). Examples of the topics follow: "Very basically, describe how the binary system works in the computer. What is a chip and what does it do? Explain RAM and ROM. Explain disk capacity, bits, bytes, kilobytes, and megabytes. What is an operating system and what type system is found in the most prevalent computers used in education today? What does compatibility mean? List the major components of a computer system and explain what they do. Trace the evolution of the computer and explain the advancement made at each step. Using *MACWORLD, Electronic Learning, Educational Computing Research, Educational Technology*, share several 'hot topics, etc.'"

The second jigsaw task involved students participating in expert groups (Johnson, Johnson, & Smith, 1991, 4:17). An expert group consisted of the members from each home group who were responsible for researching and teaching the same part. In the expert group meeting, each student shared his/her research and answers. By conversing and sharing with other experts on the same subject, incorrect information was clarified before the students taught the information to home group members. Expert groups were also given the task of discussing how best to teach the material to their home groups.

The third task was to have each student teach the home group (Johnson, Johnson, & Smith, 1991, 4:17). The students were asked to praise, encourage, ask questions, relate information to previously learned material, and check to make sure each group member understood all that was being taught. A growing problem was that some students were inadequately prepared and others were over prepared. A few students taught their parts with such intricate detail that the learning students were overwhelmed and intimidated.

The final step was to require each home group to create a newsletter containing the newly learned information. The quality of information brought in and placed in the newsletter was important since this would be the only material allowed to be used as a resource during the upcoming test. During the preparation of the newsletter, students were encouraged to use a variety of computer software: SuperPaint, Printshop, word processing, and PageMaker.

Other cooperative strategies were incorporated into the lecture and the effectiveness of each cooperative experience was evaluated by having the students individually rate each activity using a Likert scale. The Likert scale included the numbers 1 though 5, with 1 being "agree strongly" and 5 being "disagree strongly," to each of the following comments: "This was an effective teaching/learning strategy. I would have preferred that the material be taught differently. I would use this teaching/learning strategy myself." Individual opinions and suggestions regarding the cooperative learning were also gathered from the students using the university telecommunications network. The EDCI320 students were able to send private messages reflecting their thoughts on the cooperative learning to their instructors using electronic mail. In addition, the EDCI320 class established its own newsgroup, where both students and instructors could post class announcements, discuss thought provoking questions, and reflect on the cooperative strategies used. When a teacher or student posted a message to the newsgroup, the message was listed in the newsgroup for all subscribers to see and to respond.

An analysis of the Likert scale ratings and telecommunication comments revealed that one of the most popular activities was allowing the students to take one test as a group, with each individual able to redo any questions missed to recover lost points. The next most popular activity was having each group member be responsible for reading a handout on a particular topic (e.g. characteristics of one type of CAI) and then teaching the rest of the group about the topic. One of the least favorite activities was using name tags. The Likert rating on the jigsaw was low in relation to some of the other cooperative activities, for a variety of reasons. First, some students did amazing amounts of research and then literally inundated their group members with detailed information. Teachers using this approach must monitor the amount and detail of information shared. Second, lecture size was a problem. With 60 students in each of the three lecture classes, the noise level made hearing difficult when students were in groups of four or five. An especially interesting result of the cooperative learning was that several students said they did not like cooperative learning because "It put too much pressure on me to attend class" or "I felt like I always had to have my homework done because my group was counting on me." Several students even said, "Why don't you just 'tell' us what we need to know; it's a lot easier." Since many college level courses are taught in the traditional lecture method, students are so accustomed to that method that they are more comfortable sitting passively, being told what to think while taking notes. The challenge of cooperative learning puts pressure on the student to be productive and use higher-level thinking skills.

Cooperative Learning in Lab

Cooperative learning was incorporated into the lab experience to see if better results were achieved when students worked in cooperative learning groups versus working independently on assignments and projects. Students worked in groups of two or three on a computer to perform creative thinking activities, learn various pieces of software, and design and produce materials. As had been done in lecture, each student was assigned a responsibility, with one student being the reporter, who input the information on the keyboard, one student being the encourager, who made sure each person was participating and receiving encouragement, and one student being the checker, who made sure that each team member understood what was being discussed and accomplished (Johnson, Johnson, & Smith, 1991, 3:3-3:6).

Evaluation of the lab cooperative learning methods using the Likert scale ratings and telecommunication comments indicated that the students agreed that they preferred working in the lab using cooperative learning versus working independently on the projects. Evaluations also indicated that cooperative learning in this situation was extremely effective. The labs actually ran more smoothly because the students taught each other with less intervention from the instructor. Instructors should be cautioned, however, that allowing students to complete assignments in groups may mean that a few individuals never really learn the lab software being taught because others in the group can complete the assignment with little or no help from that individual. Each individual, in this model, is responsible for their own construction of knowledge gleaned from the experiences provided.

TLC in Other Disciplines

Using up-to-date technology and innovative teaching/learning strategies should not be limited to instructors teaching teachers to use technology. Project TLC has served as a model for applying technology and cooperative learning in the Engineering Department and the English Department of Montana State University. Cooperative learning strategies were applied both in the lecture of ME110, Engineering Graphics (a course in computer automated design and drafting for engineering students), and the lecture of MET310, Advanced Engineering Graphics. Both courses are structured similarly to EDCI320, with a large one-hour lecture and smaller two-hour labs.

In ME110, the students were placed randomly into groups of three, where they worked collectively to decide how to project a three-dimensional object on paper. The group was only allowed to ask the instructor a question if no one in the group could answer it. The goal of each group was to assure that each member understood the solution by the end of class, and then each group member had to write up the solution individually and hand it in as homework. In MET310, the students were placed randomly into groups of three, given back a graded exam, discussed the questions they missed as a group, and then were allowed to individually write the correct answers to the questions they missed (in more detail than required on the exam) in order to regain points. To the surprise of everyone involved, the engineering students gave a higher average weighted Likert rating for the cooperative learning used in the ME110 and MET310 lecture than the future teachers gave in the EDCI320 lecture. This could be partially due to the fact that the ME110 and MET310 instructor had been informed of all problems encountered in the EDCI320 class, such as students bringing too much detailed material back to share with classmates, and was able to avoid many of the inherent pitfalls by structuring the cooperative learning strategies more effectively.

Similar positive results occurred when computer technology and cooperative learning strategies were used in an ENGL001 basic writing class. The students were split into groups of three working on one computer and instructed to use the drawing function to circle the subject, put a square around the verb, and to grammatically correct each sentence that appeared on the screen. A class tutor was assigned to each group to keep it on track and to assist if problems occurred. Because the students knew they would have to do the exercise by themselves if they did not attend the class and participate in the group, all students except one attended. This was one of the record attendance days for that class. In addition, tutors reported that the conversations among group members were stimulating and extremely educational. A similar exercise was tried the next class period, only this time the groups had to use the computer to put sentences into a logical order that formed a paragraph. This exercise did not work as well because the students could not see all the sentences on the screen at the same time and the members of some of the groups had problems clearly seeing the large amount of information that appeared on the screen. Using technology and cooperative learning undoubtedly creates new problems that must be worked out as the teacher experiments with appropriate teaching strategies.

The Follow-up

The semesters following the initiation of Project TLC continue to provide an opportunity to assimilate the best of all that was learned about incorporating cooperative learning and technology into the classroom. As a result of Project TLC, the one-hour lecture has been combined with the two-hour lab to allow for smaller group experiences and increased use of presentation technology. This arrangement makes it easier to weekly adjust the amount of time allotted for lecturing, cooperative groups, and the hands-on lab.

Active cooperative learning experiences continue to be designed into the lecture portion of the now three-hour lab. Lecture material continues to be incorporated into HyperCard. PowerPoint presentations, combining graphics, text, color, and appealing templates, continue to be used in disbursing lecture information. These presentations allow students to see an outline of the material while they are hearing the teacher explain and discuss it. Students who don't like taking notes or who would like a copy of their own can copy the file and PowerPoint Viewer to their own disks and peruse the material, as many times as they wish, at their own speed . In addition, students are encouraged to learn PowerPoint themselves to use in the future for their own classroom in whatever discipline they will be teaching.

While various teaching/learning techniques (such as reading in the textbook, learning through HyperCard, and discovery through cooperative activities) will continue to be incorporated into the class to help the student understand critical information, completely eliminating the lecture has been found to be unreasonable. A minimal amount of lecturing will still be used, with PowerPoint used to enhance this lecturing.

Conclusion

The combination of technology and cooperative learning can serve as a powerful tool for all teachers, regardless of discipline. Teachers should be encouraged to effectively integrate technology into their teaching and to model teaching strategies that encourage students to use critical thinking and to take responsibility for learning by becoming active participants.

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Computer Literacy Class for Preservice Teachers at University of Texas at Austin

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Today's classrooms mandate that beginning teachers possess the necessary skills to integrate technology into the curriculum (Marker & Ehman, 1989). Yet, many teacher preparation programs only teach basic "how to" computer skills and not how to teach with computers (LaFollette, 1992). In an interview with Terry Theriault, Coordinator Instructional Technology, Austin Independent School District (1994), she related that new teachers typically are barely proficient with software applications. Further, the new teachers have little or no knowledge of how to implement technology into the classroom. This paper describes a solution to the problem of providing preservice teachers with the skills and attitudes they will need to integrate technology into their classrooms.

Related Research

Some startling statistics from the Office of Technology Assessment (1988) indicate that although 89% of all schools of education offer some type of computer training, less than one-half of the teachers surveyed used computers regularly in the classroom. Only one-third of the kindergarten through twelfth grade (K-12) teachers have had ten hours of computer training. Furthermore, less than one-third of education majors surveyed considered themselves prepared to teach with technology.

DelCourt and Kinzie (1993) in a study of 328 undergraduate and graduate students enrolled in schools of education at six geographically separated universities found that 15% of the students have never used word processing, 53% have not used electronic-mail, and 45% have not used CD-ROM technology. Results of the study suggest that experience and attitude go hand-in-hand — increased experience results in a more positive attitude towards future implementation of technology in the classroom.

In a review of the literature of seventy-two studies of the application of technology to teacher education (Brooks & Kopp, 1989), the authors identified six factors which influence preservice teacher preparation: (a) A professional "knowledge base" should be developed through the systematic infusion of technology into the teacher preparation program and the development of a virtual teaching community via the involvement in telecommunications from the beginning of the professional sequence; (b) The terminology associated with technology is difficult; (c) Purchasing new technology has traditionally been a low priority; (d) Leading edge technology is very expensive; (e) Faculty should be adequately trained in the use of technology; and (f) Continual planning is required to develop and maintain an effective program.

The U. S. Congress Office of Technology Assessment (1988) recommends four goals for preservice teacher education: Training in technology skills; exposure to emerging technologies; support for implementation/experimentation in technology; and extended time for use and practice. The curriculum design for the Computer Literacy class at UT at Austin addresses these four goals by teaching technology skills as well as the implementation process.

Computer Literacy for Preservice Teachers at UT

Each long semester, seven sections of computer literacy classes targeted to preservice teachers are offered by the College of Education at The University of Texas at Austin. All sections are taught by Ph.D. students enrolled in the instructional technology program. Six of the seven sections are team-taught and all decisions pertaining to curriculum are collaboratively developed by the instructors and their supervising professor. Class sections are limited to thirty students.

Reaching Consensus

The Computer Literacy class is dynamic and evolving as a result of a consensus process between the supervising professor and the assistant instructors. Four major components contribute to the consensus process:

1. Two semester planning sessions which usually run from four to eight hours are held prior to the beginning of the semester and immediately following the end of the semester. During these meetings, curriculum requirements are carefully reviewed and revised when appropriate.
2. Student feedback is considered essential. Instructors conduct formal and informal surveys to assess students' attitudes and needs. This data is used in the decision-making process to evaluate the current curriculum.
3. State-of-the-art technology and innovative research are reviewed for application into the curriculum and adapted when feasible.
4. Two-hour monthly meetings address ongoing concerns and changes are implemented to address identified problems/issues.

Nuts and Bolts

The curriculum has evolved into one that is competency based with practical, application for classroom teachers. The emphasis in all class activities and competencies is pragmatic. For example, spreadsheets are taught in the context of creating an electronic gradebook which should be of future, professional use.

All students take the class on a pass/fail basis and must complete all the required competencies. Students are permitted to resubmit each competency up to three times until mastery is achieved. Instruction and proficiency must include three different platforms: Apple II, Macintosh, and IBM (MS-DOS). The individual instructor decides which competencies to teach on which platform.

A typical class is team-taught in the computer lab and consists of demonstration of the specific competency by one of the instructors using a LCD panel and overhead projector. Immediately following the demonstration, students participate in hands-on activities. Both instructors provide assistance during the guided-practice. Due to a limited number of computers available for use in the computer lab, students must work in small, collaborative groups during the class time. The mandatory collaborative work is viewed by the instructors as being a positive vehicle to teach cooperative learning techniques.

Competencies and Final Project

Following are descriptions of the eleven, required competencies and the final project:

Print Shop (or similar) output. Students design a greeting card, letterhead and sign (for use in the classroom). The competencies begin with Print Shop because the program is easy to use and all students are assured of success, especially the students with no previous computer experience.

Word processed document with text and graphics. Students produce a five-page document about observing copyright laws in the classroom with a cover page which include the following elements: centering, boldface, underline, pagination, spell-check, header, footer, table, bibliography (American Psychological Association format), different fonts, font sizes, or letter formats (i.e., shadow, outline, etc.), and two graphics/illustrations which add meaning to the text.

CD-ROM & UTCAT searches for information for other class assignments. The competency consists of one UTCAT and 2 CD-ROM database searches (i.e. different interfaces) of one topic. For this competency the class is held at the library. After a tour of the technology facilities at the library, the procedures for an ERIC search are demonstrated to the students. The topic for the searches are self-selected by the students and should be adequately explained so the printouts of the searches are meaningful to the instructors.

Electronic-mail practice using TENET (Texas Education Network). Students send weekly electronic-mail (e-mail) messages to their peers, instructors, and/or Texas classroom teachers for a minimum of ten weeks. The e-mail messages incorporate the use of an original message, a reply, a distribution list, and a forwarded message. Perhaps, the most stimulating facet of the competency is the communication with a K-12 classroom teacher who is currently using technology as an instructional strategy. A positive benefit noted by the instructors is the mentoring relationship which develops between computer literacy students and the classroom teacher.

Readings discussion on class computer conference (TENET). Each individual computer literacy class section has a TENET newsgroup devoted especially to their specific class. Over a five-week period students read and critique technology related articles and post the critiques to their individual class conferences. In addition, they respond to the critiques and discuss ways the technology may be used in their future classrooms. To demonstrate the wide audience for on-line conferences and the variety of newsgroups available through TENET, an "everyone" group serves all seven sections. Students post information concerning interesting postings found in non-class TENET conferences to the "everyone" group.

Internet searches for information. Using the TENET Internet Resources menu interface, students access information via telnet and Gopher. A more advanced process requires the students to use telnet and/or ftp from the TENET (i.e. Unix) prompt. The exact steps required to reach the specific information is turned in to the instructor with a brief summary of the findings at six different Internet sites.

Software evaluations. Three different educational software packages are analyzed by students. Individual instructors have developed different procedures to satisfy this competency. Some instructors require the students to submit the analysis as a written report while other instructors prefer database entries accompanied by a classroom presentation of the software analysis.

Creation of a database for future professional use. Students develop a class records database with a minimum of ten fields and ten records. Database functions such as sorting and finding are required. The database is typical of a professional tool for use by the classroom teacher to prepare student records and/or send home individual communications.

Spreadsheet and graph. Typically students develop a gradebook which is illustrative of one which could be used in their future professional setting. The spreadsheet must include functions such as average, standard deviation, minimum score, and maximum score. Representative graphs are charted for possible use at a parent conference; a written paragraph explains the graph and the potential use.

Logo composite picture. The competency includes creating the following: a composite picture that can be drawn with the turtle by typing just one word and pressing the <return> key; at least three shapes and/or patterns; two different repeat statements; two different turtle stamps; filled/shaded area; superprocedures with at least two subprocedures; at least one text label; and circles/arcs of any size. Collaborative work is encouraged by some instructors for the Logo competency. Students work in small groups to create their Logo picture. This is the most controversial competency. Instructors have debated every semester whether or not this competency should be included. Positive arguments focus on Logo's ability to develop thinking skills. On the negative side, only minimal skills are taught due to time limitations. In order to successfully implement Logo in the schools, computer literacy students would have to have additional training.

Simple instructional HyperCard stack. The students develop a fifteen-card, instructional HyperCard stack in their teaching field which includes the following elements: cards, buttons, and fields; a navigation menu bar; at least one piece of clip art; at least two different backgrounds; at least two different special effects; instructions for how to use the stack; and a way to exit the stack. This project may be completed by small, collaborative groups.

Computer purchase/integration plan project. The final product is a ten-page, double-spaced paper. The students develop a classroom integration plan for the use of technology in their future classrooms. The plan should be realistic and pragmatic with a philosophical substantiation defending the use of technology over traditional methods. The paper must include the required hardware and software to execute the plan, with prices and rationales for their selection.

Conclusion

Although we believe our class is quite comprehensive and as thorough as we can make it at this point, several problems consistently arise:

- Accessibility - Typically, in our experience, in one section of Computer Literacy less than a handful of students own or have ready access to a computer at home;
- Experience - At best, most students' computer experiences have been limited to simple word processing;
- Cost - While we are fortunate at The University of Texas to have connectivity, students must pay ten-cents per day for Internet access and electronic-mail. Preservice teachers are required to pay $25.00 for a yearly TENET account in addition to the university tuition and fees which includes a $9.00 per hour technology charge.

Additional problems have been identified by Glenn (1993). In recent years there have been cuts in universities' budgets. Typically, colleges of education are at the low end of the hierarchy for funds. Therefore, funds are not usually available for up-to-date hardware and software. At The University of Texas funds are becoming more available but the process has been slow. A state-of-the-art computer lab is in the developmental stages. Glenn also identifies three curricular problems. Usually only one or infrequently two computer literacy classes are required by the teacher preparation program. Technology is not systematically integrated into the professional sequence. Therefore, preservice teachers do not see technology modelled in their programs nor do they have the advantage of using technology in their own disciplines. Also, technology is rarely integrated into the classroom curriculum in the practice teaching experience.

Thus, the journey from computer competency to computer integration into the classroom is a vast one for a semester computer literacy class. Therefore, we recommend that the Computer Literacy class should be required at the beginning of the professional sequence to allow students to use the acquired technology skills throughout their preservice training. Ideally, systematic, integration of technology should occur throughout the undergraduate curriculum to adequately prepare preservice teachers to integrate technology into the their future classrooms.

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Technology "R&D" for Preservice Teachers

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During the Fall 1994, staff of the University of Massachusetts Lowell, College of Education are working with preservice teachers, both Secondary and Elementary, to develop their technology skills and their awareness of the effective application of technology in instruction. The students (preservice teachers) working in "home groups" are responsible for a final assignment, a one-week instructional unit including a 40-minute lesson that incorporates one or more technologies. During the first half of the semester, one student from each group studies a particular technology and then "transfers" their knowledge of the technology to the home group. In this way, each group gathers knowledge about a variety of technologies, and each student gains a level of expertise with a particular technology. At the mid-semester point, after each group member has studied a different technology and informed the group concerning its merits in instruction, the group selects one or more technologies to use for their final assignment.

This paper discusses the development of students' confidence and expertise with a particular technology during a training period (the first half of the semester), their success in transferring their knowledge of the technology to their group at the end of the training period, and their confidence and expertise with technology at the end of the semester.

Measurement and Evaluation

Three instruments have been developed for use in the study:

1. a pre-test assessing the students' general expertise, awareness, and confidence with various technologies, their goals for the training period, and their interest in the technology they will be studying during the training period (self-reported);
2. a mid-semester test at the end of the training period assessing their awareness of the technology's usefulness in classroom and professional activities and their confidence in using the technology (self-reported); and
3. a post-test at the end of the semester combining elements of the pre-test and mid-test (self-reported).

At the end of the semester, students are evaluated by their instructors on their use of technology in a final project and the general, overall rating compared with students' self-reported expertise with technology in the post-test. Concluding comments address the effectiveness of the training model as a means of introducing preservice teachers to technology for classroom use. It is felt that requiring students to "research" a particular technology for presentation to their peers and then "develop" a project collaboratively using a technology—termed here an "R&D experience"—will add to their knowledge of technology, and their level of confidence, and willingness to use technology in instruction.

Analysis of Teaching Course with Technology Component

Preservice teachers enrolled in the UMASS Lowell College of Education initial-certification program are required to take an "Analysis of Teaching" course. The course is designed to enable preservice teachers to identify and practice good teaching skills, as well as integrate key concepts from all their courses with their personal bel efs about teaching and learning. The course is offered n two sections, one for elementary teachers and one for sec ndary teachers. Last year's STATE94 conference incl ded a discussion of the use of technology to enable pre ervice teachers to observe and talk with expert teacher via 2-way television (McDevitt, 1994). This year's revised ourse includes a significant technology experience, as desc ibed above, designed to give students first-hand experience with instructional technology and require them to in egrate technology appropriately and effectively in an nstructional module of their own design. The new technology omponent was carefully researched and planned by two fa ulty, Dr. Anita Greenwood (Secondary) and Dr. Margaret McDev tt (Elementary). Handler (1993) notes the importance of h nds-on experience with technology and modeling of t chnology in instruction by teacher education faculty. "Although a single course introducing teachers to tec nology use in education is very important for some, it is n t enough for most preservice teachers. Equal attention, it appears, should be given to the technological climate in-which the students have 'hands-on' and 'minds-on' opp rtunities in their methods courses and their pre-clinical and student teaching experiences...This may mean the re xamination of course syllabi to provide both hands-o experience during class and assignments requiring he use of computers as well as faculty modeling computer-use." Davis

(1993) surveys approaches to echnology preparation for preservice teachers and note an integrated approach "which introduces skills students a e expected to exercise later in their course." Dav s also notes the 1989 United Kingdom Council for Accredi ation of Teacher Education (CATE) objectives which stress confidence with a variety of software packages and informat on technology devices; critical review of software and hardwar-e in regard to their value in the classroom; construc ive use of technology in teaching; and evaluation of he ways in which technology changes the nature of teachin and learning. The CATE guidelines particularly ask teac ers "to prepare and put nto effect schemes of work incorporating uses if inf rmation technology." It is these findings in regard to reservice teacher preparation in technology that for ed the basis for the "R&D experience" planned for UMASS Lowell College of Education preservice teachers in the Fall of 1994. The planning included discussion with four d ctoral students at the college who have expertise with on or more of the technologies selected for study and who woul provide the training for students during the six-week train ng period at the start of the semester. The same doct ral students would also provide guidance and support for stu ents as they developed their technology-infused final projec College's Instructional Resource Center in the Macintosh Lab or in the new Multimedia Classroom. Alternatively, activities were scheduled at the Center for Field Studies and Services.

Entering Technology Profile of Students

At the beginning of the semester, students answered a questionnaire designed to ascertain their level of expertise with technology, their perception of the usefulness of technology in instruction and their level of confidence with using instructional technology. They were also asked to indicate their goals for the six-week training period. Twenty-one elementary and twenty-five secondary students responded, for a total of forty-six students.

The profiles differed somewhat between the elementary and secondary students. Elementary students had an average of 4.9 years experience in computing, ranging from 0 to 15, with a standard deviation of 3.5. Secondary students averaged 9.7 years, ranging from 0 to 24 years, with a standard deviation of 5.7. The mean for both groups was 7.5 years experience with a standard deviation of 5.4. As must be expected, most students reported more experience with Word Processing than with the eight other technologies (Database, Spreadsheet, Graphics, Multimedia tools, Data communications/Internet, Presentation tools, Concept mapping or brainstorming, and Instructional packages). All of the secondary students reported Intermediate or Expert level of knowledge with Word Processing, compared to only 12 of the elementary students (about 60%). Nine secondary students reported Intermediate or Expert knowledge of Spreadsheets. Otherwise, fewer than 20% of either group reported Intermediate or Expert knowledge of any of the technologies.

With one exception, secondary students expressed a high (n=7) to very high (n=17) level of interest in their forthcoming training experience. With no exceptions, elementary students expressed high (n=6) to very high (n=15) level of interest.

Desire to master the technology differed significantly between the two groups. Two secondary students (including the one with no interest) had sub-par goals for technology mastery during the training period. None had moderate goals. Eight wanted to learn all they could during the training period, and fifteen wanted to be able to teach the technology to others. The elementary students presented a different profile. Five wanted to learn the basics of the technology; eight wanted to learn all they could; eight wanted to be able to teach the technology to others at the end of the training period. The responses did not differ significantly by the technology under study.

For both groups, their perceived ability to teach with technology was generally in line with their current level of expertise. Only three students (one secondary and two elementary) were slightly over-confident, and no single factor explained with this response.

Description of Training

During the six-week training period, students were assigned to study one of four technologies: concept mapping and brainstorming using Inspiration; instructional packages, using a variety of CD-ROM and laser disk interactive packages and the Stella simulation package; multimedia production tools using Action; or data communications, featuring Internet tools, especially Mosaic. Each strand of training was handled by one of four doctoral students with technology expertise. Preservice teachers were expected to spend a three-hour period one day per week for six weeks learning the assigned technology.

The concept mapping group (9 students) learned the rudiments of Inspiration for diagramming, brainstorming, concept mapping, and synthesis of ideas. Their key assignment was the creation of a personal family tree.

The group studying instructional packages (13 students) learned to install software and activate CD-ROM and laser-disk-based packages. They evaluated various packages, including SimEarth and SimCity, and they compared packaged systems to the general simulation capability provided by Stella.

The multimedia tools strand (8 students) made use of the multimedia classroom at the school, with a Macintosh Quadra 660 AV, 20 MB memory, CD-ROM, connected to a high-resolution color display panel for overhead projection and four ceiling-mounted speakers. Students learned the basics of multimedia production. To transfer their knowledge to others in their home groups, they produced a short multimedia presentation showcasing audio, graphics, image, and formatted text. They discussed how the technology could be used in the classroom and in support of instructional activities.

The Internet group (16 students) studied electronic mail, listserv's, Gopher, and Mosaic in regard to the curriculum and instruction materials available through Internet and the professional support available from expert practitioners. They were particularly impressed by the lesson plans available via AskERIC and other education-related Gophers. They were quick to see the merits of emerging Mosaic materials for classroom instruction, balanced with the reality of networking status in Massachusetts schools. They studied various classroom project models (Harris, 1993) and critiqued them from the vantage point of their subject and grade level interests. They confronted issues of inappropriate material and privacy and lack of quality control surrounding shared materials. Each student joined a listserv in his or her professional area and kept the group informed concerning the usefulness of the list.

No tests or evaluation criteria were applied to student efforts during the training period, although the doctoral students leading the training made every effort to challenge all the students and to insure their understanding of the technology and its potential in curriculum and instruction.

Mid-Semester Gains

A questionnaire administered at the end of the training period, together with observation of the presentations made to home groups indicated uneven understanding of the technologies at the mid-semester point.

Observation of the presentations suggested that those students who had worked at mastery during the training period showed better understanding of the technology and were more successful at transferring their knowledge to their home groups.

The questionnaire indicated that, while all students could envision application of their technology in some subject areas, most could not generally see application across all instructional areas. Only about half the elementary students and one fourth of the secondary students felt that the technology they studied could be used successfully for classroom instruction across subject areas (language arts, foreign languages, math, social studies, and so on). In this case, the lower percentage for secondary may be a function of their specialization by subject. All participants saw application of the technology in one or more areas of instruction.

Students' perception of their technology's level of difficulty (learning curve, difficulty teaching, difficulty for experienced users, and so on) varied widely. Two of those who studied Inspiration felt that the learning curve was easy. Most students felt that the learning curve for their technology was moderate to difficult. The level of difficulty reported was not clearly correlated with years of experience or the particular technology studied or a combination of the two.

At the end of the training period, four of the secondary and two of the elementary preservice teachers expressed some apprehension about having to use technology in the final project. Four of the six were students who had reported low confidence at the beginning of the semester in their ability to teach with technology, and a fifth had reported no interest in learning to use technology in instruction.

Participants in the two most popular and populated groups (instructional packages and Internet) expressed a negative preference for their technology. That is, 10 of the 16 Internet students and 6 of the 13 instructional-package students said they would prefer not to have their technology chosen for the final project. Others in those groups were strongly in favor of using their technology for the final project. The final questionnaire will probe more into this area.

Final Projects

While the final projects are still in progress, there is some indication that not all students are taking the easiest route to technology integration by using an existing interactive instructional package. Students have proposed using a spreadsheet for a science-related lesson; using Internet for classroom interaction; and using brainstorming tools with the class. It should be noted that there is no restriction on use of technology in final projects. Groups are free to use one or more technologies, and they need not use the technologies studied during the training period.

Students will be rated on how well integrated technology is with the final lesson in the context of the week-long instructional unit. They will also be judged on how competently they use technology and how knowledgeable them seem to be concerning the technology.

The final questionnaire for the students will query them on their decision to use or reject the technology they studied and what reasons they had for choosing the technology or technologies they incorporated into the final project. The questionnaire will endeavor to distinguish between pedagogical reasons for choosing a technology versus expediency or manageability.

Final Evaluation

The ultimate test of the program's effectiveness is whether the preservice teachers make appropriate use of technology in instruction during their practicum and in their own classrooms in the years to come. In the short term, however, the technology "R&D experience" will be evaluated in two ways.

First, as noted, students' use of technology in their final projects will be graded using criteria that includes appropriateness and effectiveness of technology, apparent knowledge of the chosen technology and competence with technology in the final lesson.

Additionally, a final questionnaire will ask students to report their end-of-semester level of expertise with the original nine technologies, their level of confidence using technology in instruction, and their reasons for choosing or rejecting a particular technology for the final project. We would expect to see gains with certain technologies, especially those studied and used in the final project, We will also query students concerning the structure of the R&D experience and which aspects of the program they found to be most effective for their own development.

The R&D experience will be evaluated using a combination of the methods above, and the results will be factored into next year's program for preservice teachers at the College of Education.

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Adding a Field-based Component to a Course in Educational Computing

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In 1993, the University of Houston became part of a regional consortium that includes four area universities, eight Professional Development and Technology Schools (PDTS), and regional education service centers. The primary goal of the consortium is to train teachers who are "both sensitive to the needs of an urban, low socio-economic status and culturally diverse population" and who are "capable of integrating technology into their instruction" (Robin, Tellez, Walker de Felix, Houston, and Willis, 1994, p. 794). PUMA (Pedagogy for Urban and Multicultural Action) is the University of Houston version of the preservice teacher education program. All four universities, which are supported by a grant from the Texas Education Agency, are to develolp teacher education programs with two characteristics: they are "site-based" in K-12 schools that have volunteered to become professional development schools, and preservice teachers are prepared in technology-rich environments (Robin, et al., 1994, p. 795). Each PDTS site is equipped with computer hardware and software tools to allow preservice students to accomplish these applications. With the shift to a professional development school model, two new field-based, educational computing courses, CUIN 3312, *Information Technology for Young Children* and CUIN 3313, *Information Technology for Adolescents*, were developed to support the PUMA model at the University of Houston.

Theoretical Foundations

The philosophy of these new courses is based on an understanding of learning as a dynamic and continuous process that must be "sustained and strengthened by a multiplicity of experiences from which students then construct their own experiences and explanations" (Jonassen, 1994, p. 35). When students learn factual material or procedures from a didactic lecture they often cannot use such material to solve real-world problems. This type of knowledge is what Whitehead (1929) calls "inert knowledge" - knowledge that is separated from the context of use and therefore inactive or "inert." Such training, which is common in "computing for teachers" courses, often cause students to loose sight of the "why" (Cognition and Technology Group at Vanderbilt, 1992) and they are unable to apply this knowledge in various circumstances. Recent educational research (Cognition and Technology Group at Vanderbilt, 1992; Jonassen, 1994) indicates that situating instruction in realistic or authentic contexts (either real or simulated) helps students learn both the "how" and the "why." Both of the new courses continue to hold regular "lab" sessions on campus where basic computer literacy skills are learned and practiced, and the courses still have large group presentations where students see presentations on both basic computer operation and the intergration of technologies into the classroom. Two aspects of the course, however, reflect the move toward adding more realism and authenticity to the course experience: microteaching and consultation services for teachers.

The Course

To increase the emphasis on experience in the schools and decease the emphasis on lecture/discussion and computer lab components of the course, both the new required computer-focused courses were modified to incorporate a field-based component. The old course was also split into two new courses based on certification requirements. The addition of a course to support the secondary and all-level students recognized that the information technology and curricular integration needs of secondary and elementary students is different (Brownell and Brownell, 1994).

The course has three major purposes. The first is to provide a solid foundation of basic computer and information technology skills which are expressed through the actual application of personal productivity skills to the creation of materials and documents likely to be produced by a teacher: letters to parents, gradebooks, databases of student information) In addition, databases and telecommunication are used as on-going applications in the course to support the preservice educator. These applications assist the students in keeping logs of their activities and communicating with other students, instructors, and field-based teachers. As implemented, the information technology skills to be learned are anchored in real world applications relevant to education.

The second focus is on the integration of technology into the curriculum. This focus is accomplished traditionally through readings covering the educational uses of technology (Maddux, Johnson, and Willis, 1992), demonstrations, and presentations on alternative uses of technology in education. Students also select software relevant to the subjects and grade levels they plan to teach and write an evaluation. Less traditional is a microteaching component. Students complete microteaching activities that require them to create at least two lessons incorporating technology and teach short segments to others in the class. This activity may be completed by groups, but all students are involved as a "teacher" in at least two microteaching exercises and they are "pupils" in many more. (Note: microteaching was temporarily dropped because of the time and effort required to include work with teachers in area schools but will be again included in the course starting in the summer of 1995.)

The third major purpose is to provide experience in schools with teachers who are interested in using technology. This field-based component is accomplished by dividing the students into small groups of 4 to 5 students and assigning them to teachers in local schools. These teachers may or may not have computer experience but all have expressed an interest in exploring either either personal productivity or curricular integration of technology. Students must interview the teachers to learn their interests and needs. Teachers are helped to narrow their focus to one request. After the request is discussed with their instructor, the group returns to the university setting where their job, with the help of their instructor, is to develop alternatives related to the problem the teacher has posed. These alternatives are identified through electronic searches (ERIC and Internet resources) of the literature (journals, magazines, books, and other electronic resources), discussion with group members and their instructor, and evaluation of various software alternatives. The group compiles a "consultant portfolio" which explains to the teacher the two or three alternatives suggested supported by literature reviews and software evaluations. The portfolio also contains a list of equipment and software required for the suggested alternatives. The students share this portfolio with the teacher and give an electronic presentation (using PowerPoint, HyperCard or a similar program) of the alternatives proposed. This presentation includes demonstrations of any software proposed.

Impressions, Issues and Future Plans

The first implementation of these two courses in the fall semester of 1995 was somewhat chaotic. Staff, including the author, expressed doubt that there would be enough teachers interested in participating to support 200 students a semester. They also doubted 200 students, many of them attending school and working as well as taking care of children, could be scheduled for two school visits a semester. However, as the semester progressed teachers were found who were interested in using technology, but the process was complex and difficult. The problem was not, however, due to the lack of interested teachers. Many more were interested than could be accomodated. A great deal of time was invested in finding the appropriate authority to give permission. In addition, the final list of schools participating in the project were scattered over the greater Houston area. Since the goal was to assign students to groups by teaching specialty or subject area, location and scheduled times for appointments in the schools were less than pleasing to some students who had class schedules and work schedules to consider. Some of the group assignments were less than ideal because the work and childcare schedules of students were considered. Even with those accomodations, scheduling and travel time were problems for some students.

Resources to support field-based projects presented another problem. Although the University of Houston has networked IBM and Macintosh labs allocated for these courses, the participating schools had equipment ranging from Apple II to Macintosh with few if any IBM computers. Since the university lab has only a few Apple II and IIGS systems, allocation of resources on campus for software evaluation was difficult when Apple II software was involved. [In future semesters students may be required to use the software preview centers in two large districts in the area and at the regional education service center.] Software available at the schools did not always match that available at the university and, in some cases, university resources could not be taken to the schools due to site licensing restrictions. However, since the equipment and software desired are not always available in the real world, the students experienced and worked through problems similar to those a computer-using teacher experiences today in many districts.

Although working in groups was a problem for some students (some students not participating fully while others perceived they were doing all the work), the experience for the students as a whole was successful. During the group project, students were encouraged by their instructors to allocate the work load equally among the members of the group. Each group submitted to their instructor a list of responsibilities, responsible parties, and two members of the group who would check each responsible student's progress. This procedure, which probably helped, did not completely eliminate the problem. The staff is working on alternatives.

In this paper I have pointed out problems anyone planning a similar approach should consider. However, our experience suggests the results justify the effort involved in adding more authentic experiences to "computers in education" courses. When students completed a written evaluation of the course, they found working in groups to be generally rewarding and recommended that groups be assigned earlier, during the basic skill development phase of the course, because they enjoyed sharing ideas and learning from each other. This form of peer tutoring will be incorporated in future semesters. Informal reports from the teachers who participated in the field-based component were very positive. Many asked to be assigned students in the following semester. Combining learning experiences with service to practicing teachers appears to be a win win situation in which all benefit. This approach is, however, much more demanding on the instructor. Programs planning to change from a traditional lecture/demonstration format to this approach should probably look carefully at the load involved. An instructor might reasonably teach three or four sections of a traditional educational computing course, but teaching four courses that include a substantial amount of work out in schools would be more like supervising 75 student teachers than teaching four lecture courses at the university.

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Enhancing Preservice Teachers' Computer Attitudes Using a Field-Based Educational Computing Course

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At the University of Houston, the field-based educational computing courses, *Information Technology for Young Children* (CUIN3312) and *Information Technology for Adolescents* (CUIN3313), are designed to enhance preservice teacher's ability and interest in integrating technology into the curriculum. Although the courses are "content rich" and considered difficult by many students, the attitudes of students toward technology is also important.

Purpose of The Study

The purpose of this study was to examine the relationship between attitudes toward computer use and the background variables (age, gender, academic year, learning experience, future teaching field) of preservice teachers.

Method

The subjects (N=92) were 77 female and 15 male preservice teachers enrolled in field-based educational computing courses that included both hands on lab work at the university and work in K-12 classrooms with teachers who had expressed an interest in using technology (but who were not necessarily current users or experts). The preservice students were between 20 and 47 years of age, with a mean age of 26.7 (±6.5). Within the subject population, there were 53 (58%) seniors, 23 (25%) juniors, 6 sophomores, and 10 post-baccalaureate students (those with a bachelor's degree completing requirements for certification). Most were planning careers in elementary education (72%), but there were some preservice secondary education teachers (21%) or other majors (7%). Computer experience ranged between 2 to 210 months, with a mean of 3.5 years.

An survey instrument consisting of 10 questions (answers were options on a 5-point Likert scale) along with a background information form was formulated, distributed and collected at the end of the course. The survey instrument was designed to measure the attitudes of the preservice teachers toward future integration of computer technology into their own curriculum and classrooms. Content validity of the instrument was evaluated by three experts in educational computing.

Results

Routines in the Statistical Package for Social Science (SPSS^{X}) were utilized to conduct the statistical analyses. Reliability of the instrument that measured attitudes was first tested. The alpha coefficient (Cronback, 1951) was 0.86, indicating the instrument had an acceptable level of internal consistency. A regression analysis showed that each student's level of previous computer experience correlated well orrelation coefficient $r=0.344$; $p<.001$) well with positive attitudes toward compute use. However, the correlation coefficient between age and attitude toward computer use ($r=0.184$; $p=0.079$) was not significant. Further, when gender, college grade level, and major were considered in an analysis of variance (ANOVA), no significant differences in attitude were found.

Discussion

The relationships between background variables and the attitudes of preservice teachers toward computer use were examined in this study. The findings of a positive correlation between computer experience and attitude toward computer use indicates that as computer knowledge and experience increase, attitudes toward computer usage become more positive. However, the data does not support the hypoethsis that there is a relationship between other background variables such as age and attitudes. The results are consistent with previous research (McInerney, McInerney and Sinclair, 1994; Igbaria and Chakrabarti, 1990). Of course, the relationship between use and attitudes could be due to self-selection: those who have positive attitudes tend to use computers. However, if the reverse is true at least to some extent —those who acquire experience with technology tend to have positive attitudes about it—then requiring educational computing courses for teacher education students is likely to enhance both their skills and their attitudes toward technology in the classroom.

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What If We Teach Integration, Not "Computers"?

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CIMTE 365, Microcomputers in the Classroom, is required of students seeking teacher certification for the College of Education at the University of New Mexico. It was designed to present computer technology in a problem-solving, interdisciplinary environment which focuses on the integration of traditional content, making sense of experience, and a wide range knowledge, with computer technology as a vehicle for emphasizing learning processes (Norton, 1992). The purpose of this course is to aid preservice educators in developing a vision of the potential computer technology offers for impacting teacher roles, student-teacher relations, curricular content and the learning environment. This study took place during the Fall 1994 semester and it examined the effects the technology experience had on the attitudes, intended uses, and perceived effectives for classroom use of the student participants.

Technology and Education

The United States leads the world in the number of computers in its schools with an installed base of 99% of all elementary and secondary schools; 93% of the students use them sometime during the school year. Nevertheless, American students are less computer-knowledgeable and their teachers get less training than their counterparts in other parts of the world. Despite the placement of technology in schools, technology has not been the salvation that some hoped or predicted (Hasselbring, 1991).

In the past it was thought that educators should learn how computers worked and should be trained primarily in computer programming. They were encouraged to study computer languages such as BASIC and PASCAL as part of their teacher education. Today, it is felt that teachers need to learn not HOW computers work, but how to USE computer technology in the classroom (Finkel, 1990). It is apparent that, although American K-12 schools have computer technology resources, K-12 teachers do not have meaningful strategies with which to integrate their classroom use effectively.

Technology and Teacher Education

Schubert (1986) comments, "The most salient force in the curriculum improvement process is the professional educator, specifically the curriculum leader and the teacher" suggesting that the key to improvement of education is professional development at both the preservice and inservice teacher education levels. The focus for change, teacher development research indicates, should be on inservice teachers and the programs that inform their practice (Katz, 1972; Norton, 1994), and "If teachers were supplied with appropriate technologies of instruction and trained to use them effectively, they would be freed to focus on what they can do best if properly educated..."(Fawson & Smellie, 1990).

Although most programs for teacher education provide some computer training for preservice educators, many do not have up-to-date equipment or faculty with technology expertise, which makes the situation no more promising for those just entering the teaching profession than for inservice teachers (Hasselbring, 1991) who report their training as being about computers, not learning with computers.

Persky (1990) states that teacher training in technology must go beyond booting up machines and formatting disks, to an instructional focus which guides teachers to reflect on their curriculum and their students.

The concerns about preservice teacher education in the integration of technology are well documented in research literature. For example, "... it needs to be drastically altered" (Persky, 1990); "...technology does not permeate a student's typical preservice education experience, and that is a major impediment to technology use once they become teachers" (Bruder, 1993); undergraduate instruction is not known for producing exemplary teacher models, and preservice teachers see little modeling of effective instructional strategies (White, 1994). The National Council for the Accreditation of Teacher Education (NCATE) and the International Society for Technology in Education (ISTE) have adopted a set of preservice teacher competencies for technology education, contained in thirteen foundation standards designed to prepare teachers to utilize technology (Wetzel, 1993), but colleges and universities must make their own decisions concerning the integration of technology into the teacher education curriculum (Munday, Windham & Stamper, 1991). It is important that colleges of education widen their offerings to prepare preservice teachers to use technology effectively and begin modeling proper applications of technology in the learning process (Fawson & Smellie, 1990).

Attitudes Toward Computers

Little doubt exists that humans have a social relationship with many of their tools. People often define themselves in terms of their primary tools and develop highly personal relationships with them. For instance drivers often exhibit strong emotions about their automobiles, as do musicians about their instruments, assigning names to them, yelling at them, even sleeping with them (Lynch, 1990). Computers and their software, as they are placed in interaction with humans, fill roles as experts, teachers, and problem-solvers—perhaps recognized as more than just tools (Lynch, 1990). A computer can act like a reflective medium much as films, television, and books, meaning that the medium carries with it certain characteristics, biases, and values of the authors responsible for production; but it is also interactive, in that, with appropriate software, the computer reacts in various ways to its user.

Human-computer interaction is a complex phenomenon and the attitudes and feelings involved with the relationship are difficult to identify. However, as the role of the computer expands in our global society, it is increasingly important that educators become aware of anxiety about computers among students. Fennema and Sherman (1976) suggest that anxiety toward a subject area may affect the learning process, actually becoming a deterrent to learning. Koohang (1989) agrees that this may also be true when negative or ambivalent attitudes toward computers exist, and could be a deterrent to using computers in the learning environment. It seems likely that students' attitudes toward and acceptance of computer technology, as well as learning about computers, may be important in the integration of electronic technologies in the classroom, workplace, and home.

An Integrating Model: CIMTE 365

CIMTE 365, Microcomputers in the Classroom, is a class required of students seeking teacher certification from the College of Education at the University of New Mexico. It was designed to present computer technology not in a programming, computer-literacy, tool-using curriculum, but rather in a problem-solving, interdisciplinary environment which focuses on the integration of traditional content, making sense of experience, and a wide range of knowledge, with computer technology as a vehicle for emphasizing learning processes (Norton, 1992). The purpose of the course is to aid preservice educators in developing a vision of the potential computer technology offers for impacting teacher roles, student-teacher relations, curricular content and the learning environment.

The Study

I have been a teaching assistant for CIMTE 365 for six semesters and decided to investigate the effects of our class format and syllabus (the integration of technology in an interdisciplinary environment) on students' attitudes toward computer technology, as well as on their intended use of technology and perception of its potential effectiveness as a teaching strategy in the classroom. Reactions to CIMTE 365 from past student evaluations indicate that a change in attitude toward computer technology does occur during the semester's work. Is the change really happening (or are students just telling me "nice" things), and is it statistically significant? Does the course effect what preservice teachers see as effective uses of computer technology in their future classrooms? Are other variables, such as gender and age, or ethnicity, at work in the change in attitude toward computers?

In order to examine these questions I designed a pretest-posttest study in which students in 6 CIMTE 365 classes were invited to participate. Each student was given a survey packet the first day of class (August 18, 1994), including a 49-question Instructional Strategies Inventory (Alexander, 1988), a 29-item Computer Attitude Scale (Loyd & Gressard, 1982), and a demographic profile. They were asked to return the surveys at the following class meeting. The week of November 28, 1994, students who had completed the initial surveys were asked to again fill out the questionnaires.

Analyzing the Alternative Model: CIMTE 365

This study asked four questions related to the effects of instruction in the integration of computer technology on students enrolled in CIMTE 365.

Question One: What factors might influence the impact of teacher education on preservice teachers?

A correlation matrix of all demographic variables showed no significant relationship between age, gender, ethnicity, attitude toward computers, and the subjects' intended use of computer technology and its perceived effectiveness.

Question Two: How does opportunity for preservice teacher education influence the attitudes of students toward computer technology? Table 1 summarizes the results of the t-tests (alpha=.05) conducted to test the null hypothesis that there would be no difference in subjects' attitudes toward computers as measured at the beginning of the course in the integration of technology and again at the end.

Table 1.
Attitudes Toward Computers

	Attitude at Beginning	Attitude at End
N	22	22
Mean	3.5204	3.9216
Standard Deviation	.847	.632
Mean Difference		.4013
t-Value		-3.16
Significance		<.01

A significant difference was found between subjects' attitudes toward computers at the beginning of the course and at the end.

Question Three: What impact does preservice teacher education have on the intended use of computer technology in the classroom?

Question Four: What impact does preservice teacher education have on the perceived effectiveness of computer technology as a classroom teaching strategy?

T-test analyses of data on subjects' intended use of computer technology and their perception of its effectiveness in the classroom revealed no significant mean difference in scores resulting from measurement at the beginning of the course and again at the end.

Reflecting on the Study

Analysis of data collected in existing or natural settings, already established and functioning, rather than from true experimental design adds a variety of uncertainties. Several limitations of this study impact and constrain its generalizability to any population other than that named in the study itself: (a) Response to the surveys was disappointingly low, so the number of participants (n) is small. Of a possible 90 subjects enrolled in 6 sections of CIMTE 365 only 22 returned both pretest and posttest questionnaires. Some students related later that they had questions about how to answer the surveys and so did not return them. Having subjects complete the forms in class, not allowing them to be taken home, would probably have increased the response rate. (b) Instructors were not identical for all sections, though the syllabi from which we taught were. There were three instructors, each of us teaching two sections, so the study does not control for teaching style. (c) Treatment strategies included subjects working in cooperative groups, so they could not be isolated from each other. (d) Participants came from a population which was neither randomly selected, nor assigned, but actually were required to be in the class in which they were enrolled.

Conclusion

The data indicate a significant change in attitudes toward computer technology. When computers are introduced to students many respond positively and master the necessary computer skills quickly. However, for other students the computer represents an unpleasant and anxious experience leading to difficulties in mastering appropriate skills (Loyd & Gressard, 1984). This anxiety may take the form of hostility, fear, and/or resistance, attitudes which may inhibit the acquisition of computer skills, much as math anxiety can inhibit achievement in mathematics (Fennema & Sherman, 1978).

If positive attitudes increase (Clement, 1981) students can master the computer skills involved, which then offers many advantages in the educational process: informal student interaction, absence of embarrassment, student-paced operation, problem solving, tutoring, immediate feedback, and absence of subjectivity.

Preservice education is perhaps too early in an educator's career, especially emerging from the current "front of the room" educational paradigm, to recognize the possibilities for use and potential for effectiveness of computer technology and the immense change in teacher/student roles, the classroom environment, teaching and learning strategies that it offers. CIMTE 365 is only a beginning for preservice teachers and technology, and it would seem then that perhaps a change in attitude toward computer technology is a vital first step to be taken by students on their way to becoming teachers of technology themselves. With a more positive and receptive attitude they may be less resistant to the use of technology, recognizing it as one more "trick" in their "bag of tricks," useful as an integrated part of their classrooms.

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Meeting Pre- and Inservice Teachers' Changing Needs Through Technology: Considerations for Curriculum, Classroom, and Teacher Roles

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When considering the role of educational technology in the past ten years, one readily envisions a computer station with word processing software and maybe a spreadsheet or banner making program. With our interest in the goals for students in the year 2000, we are beginning to look at what it takes to educate our children for the world of the future and what skills they will need to acquire to become productive citizens. It is interesting to explore the wide range of skills in communication, critical thinking, and even problem solving that the world of work would ask educators to consider when planning curriculum, as well as the advanced technical skills associated with the information society we have become in the United States. Technology as well as citizenship are still in vogue for reform and restructuring plans; but little is being said about the atmosphere, actual curriculum and support necessary for teachers to carry out these plans for the future.

The following paper is meant to serve as a discussion generator, a thought stimulator and a plan for what a new curriculum and classroom may include. It also presents a glimpse of what a technology ready teacher may resemble, as well as what traits may inhibit some of the most powerful uses of classroom technology. This is not an end onto itself but a beginning. This is not a description that maximizes the classroom of the future, but a minimum description. These issues as well as many others dealing with preservice education must be addressed before our schools can begin to accomplish the goals proposed by the Educate America: Goals 2000 program.

Description of the Classroom

When planning for a new program of study or curriculum, one often discusses the type of materials you will need and which objectives you wish to fulfill, but rarely does one discuss the type of facility or equipment you will need to effectively teach the course. Using social studies as an example of a content area not likely to be considered technology friendly, a picture of what a new classroom should look like will be developed in hopes of raising questions about the changes in our facilities that are necessary for the technology ready curriculum.

In the past, the social studies teacher has been shifted between English and math classrooms that may or may not have map hooks for the few visual aids that the school deemed necessary to teach the subject. With the advent of new technologies such as data bases, computer software, and audio and visual products designed for the social studies, it now seems imperative to discuss the type of space requirements for new materials and techniques for using them. The social studies of today demands an active learning environment that organizes teaching around the learning process. This requires a social studies classroom that is rich with opportunities for students to participate in decision-making, investigation, problem solving and invention. This is a marked difference from the make shift classrooms often assigned to social studies teachers in the past.

The Elementary Classroom. The elementary classroom should be a "bee hive of activity" (Connections, Challenges, and Choices, 1992). It should be large enough for students to work on projects, create displays and participate in group activities. This activity centered classroom requires a variety of resources including a multi-media center with filmstrips, tapes, laser discs, and theme related books. Within that center a minimum of one technology station provides students with access to computer based information. This information should be stored information such as that found on CD-ROMs, but also instant access to live and current data over the telecommunication waves. The classroom should be filled with a wide variety of materials and resources that allow students to work individually and in cooperative learning groups at activities that require research, creativity, publication and whatever their community and classroom can offer.

The Secondary Classroom. The middle and high school social studies facilities should continue to emphasize active learning environments. Secondary social studies classrooms should provide a wide variety of work stations that support individual and small group research, analytical and problem solving tasks. As students become more capable of functioning at theoretical and abstract levels, more sophisticated materials must be available within the classroom through telecommunication and multi-media technology that bring the world to them. Students must also move beyond the classroom walls utilizing community resources such as agencies and business partners with GIS (Geographic Information Systems) capabilities to support authentic learning activities and true community involvement.

Equipment and Supplies. Equipment and supplies for social studies should range from simple construction paper and crayons to sophisticated equipment and software for teleconferencing and satellite transmissions. In any case, it is important to have enough equipment for every student to have a hands on experience. A class of thirty students does not require thirty pieces of equipment but enough so students in groups can share materials and equipment in a reasonable amount of time. Materials and equipment should be appropriate to the learning task. Before purchasing appropriate equipment and materials, determine the curriculum and design the activities. Social studies classrooms require a variety of consumable supplies such as form-a-globes and other manipulatives along with software that would allow students to have the same experience but with a computer generated manipulative. The introduction of authoring tools and appropriate audio and visual equipment could turn what was once the subject most loathed into the most exciting with simulations, plays and programs designed by the students using their own original research and creativity. Hyperstudio and Linkway Live are two examples of easy-to-use authoring tools with great power for both the preservice teacher preparing for the classroom and the students these future teachers will expose to new models of instruction.

Technology and How We Learn Social Studies

Students live in a high tech world. To be successful they must have many experiences with today's changing technology to be prepared for tomorrow's challenges. Because of the important link between social studies and technology, the social studies classroom must incorporate the latest advances in communication and in educational technology. Technology must be an integral part of learning in a social studies classroom. A multi-media learning center that allows teachers and students to use graphics, media integration, desktop publishing, authoring tools, simulations and access to telecommunications will bring geography, history, economics and government to life.

The center should include video discs, CD-ROMS, teleconferencing and access to satellite transmissions to bring the world into the classroom. Software that promotes critical thinking and problem solving should be readily accessible to students. Students should participate in global social science activities through electronic bulletin boards that link the classroom to social scientists and other classrooms throughout the world. The National Geographic Kidsnetwork is an excellent example of real data collection and research methods being used and shared with children from around the world. Research teams are made up of international schools that share their data by means of telecommunication. Students collect their data, share their data and have a personal sense of ownership in the process. Technology makes the transmission of data and ideas affordable and fast which aids in the learning process.

What is Educational Technology? Educational technology includes all kinds of hardware and software as well as the training and skills necessary to effectively use technology to teach and learn. It is important that technology not be an end in itself, leading rather than being led by teachers and their objectives. Technology should serve curriculum and instruction, not dictate it.

What does it do? The use of technology in the classroom enables teachers to become learning facilitators rather than disseminators of factual information (Curry & Temple, 1992). Technology helps students to perform individual and group tasks, to record information and communicate "using information, concepts, prose, symbols, reports, audio and video recordings, speeches, graphic displays and computer-based programs"(Blueprint 2000, Goal 3, Standard 2, 1992.) "The computer can ease the administrative burden teachers face. It can spark and help manage incredible class discussions. It can take a group of students on a field trip to a faraway world without ever leaving the classroom. It can provide teachers with a more powerful "chalkboard" than they ever imagined, it can do all this and much more" (Dockerman, 1991.)

How do you do it? The first step is to recognize that instructional technology's effect on learner outcomes will be dependent on the effective delivery of adequate teacher training in its use (Curry & Temple, 1992). Teachers must not only become familiar with the technologies and their applications, but also spend enough time using them to learn and master their application for use in the classroom. The inservice training program should start with helping teachers acquire this knowledge. This training should include practical techniques that explore the possibilities of multimedia. Teachers should be familiar with and aware of the trade offs, pitfalls and components of full blown multimedia presentations. Training should include hands on activities to learn to develop multi-media application that can be powerful tools to communicate, teach, and demonstrate ideas. It is only after the teacher has this level of expertise that students will be able to take full advantage of the technology in the classroom.

The second step involves the students using technology in the classroom. Whether the learning environment is a single computer classroom or a classroom with a multimedia station with a telecommunications link and individual student computers, students can be engaged in active learning tasks that use technology to manage responsibilities and paperwork, make presentations, generate discussions, managed cooperative learning activities, and inspire enlightening self discoveries. Student use should not be limited to the occasional opportunity to use the computer in the back of the room as a reward for doing good work. The use of technology should be an integral part of the learning environment that stimulates inquiry and problem solving. The students' natural curiosity and practical experiences with computers and video games can make this a rich learning environment where the student often feels in control of his or her learning. If the teacher is ready and willing to relinquish the teaching reins to the students, the teacher may find him/herself in the true position of facilitator, coach or resource person while the students carry on with their learning in process as well as product. If an instructor is comfortable in a teacher-centered, dominant position, this form of instruction may seem disorganized or mismanaged.

For many teachers, the role of mentor is uncomfortable and difficult. The traditional role of the teacher, Type A teaching style (Flake, 1994), does not lend itself to new technologies nor to students taking responsibility for their own learning and exploration. The Type B teacher (Flake, 1994) on the other hand is very willing to accept the role of facilitator and partner in the learning process and will respond quite well to the introduction of new technologies (See Figure 1).

The bottom line is the realization that students of all ages and ability levels can participate in the development of their learning situations and that they bring many of the essential components with them from their past experiences no matter how limited.

When looking at the role, or in the case of a preservice teacher, the anticipated role of the teacher, attitudes and baggage more commonly associated with students must also be considered. Teachers and interns must be exposed to new technologies in a meaningful way to help them make sense of how they can best incorporate it into their classroom methods. Critical thinking, analysis, and problem solving exist without technology, but technology can take these desired student abilities to a higher and sometimes more meaningful level. This expansion of mind is unfortunately often times put aside for more simplistic and mundane tasks such as drill and practice programs and computer games that do little to challenge the intellect, but serves as a reward for early completion of work. This is often the case when teachers are given the equipment and supplies with little inservice to help them develop their own understanding of the power of technology and their changing role in using it. The colleges of education are in a similar situation with little funding to update software, hardware and materials appropriate for future teachers to explore and review.

Many technology courses are still designed to expose interns to yesterday's technology and give few opportunities to explore creative authoring tools and their feasibility for the classroom. Few courses relate teachers' delivery styles to what types of materials and activities they select and it is even more difficult to find courses that address teaching styles and how they impact the use and misuse of technology. When a course in simulation or computers for the classroom is offered, it is often not associated with the social studies curriculum. If a course is offered and attended, many elementary and secondary social studies majors not only learn about the power of the world of computers, but also the overlap of skills and concepts they once thought were exclusively social studies with the other disciplines. Technology serves another important function, the role of integrator.

The third step involves the use of technology for assessment. In addition to using technology to capture traditional assessment data, emerging technologies lend themselves to the recording of performance data associated with alternative means of assessment as well as to the tracking of process and problem-solving information through the use of simulations and interactive programs. For the first time, technology can be used to create and support assessment models that mirror the learning process. Modeling such behaviors and allowing students to test their problem solving abilities can be enhanced with accurate accessible data from worldwide sources and simulations of real world problems safely displayed on their computer screen. Problem solving models can be useful tools to push telecommunications and visual materials available past the regular class discussion. If a modeling process is used in conjunction with technology, the learner will have more avenues to explore (Flake, 1994). (See Figure 2.)

The process is the same, any model can be tested, the difference is the amount and ease of access to data along with the visual representation you can't get with a book or pen and paper assignment.

One area in which one could possibly see immediate impacts in the use of educational technology is in the training of preservice teachers. If adequate modeling is provided along with the curriculum decisions associated with using educational technology in the classroom, one could see a marked difference in the amount and quality of technology-related instruction going on in the social studies classroom. If it is understood that the technology itself has a

Model A	Model B (for Higher Order Learning)
• Content is broken into subgoals; content is lined up in a logical ordering; and instruction is delivered in a systematic manner;	• Content is accessed through problem-oriented activities that allow students to bring organization to the content themselves;
• Learning comes from external sources;	• Learning comes from within the student;
• Teacher is viewed as an orchestra director, to orchestrate and dispense learning;	• Teacher is viewed as a facilitator of learning;
• Classes are teacher-centered;	• Classes are student-centered;
• Students are viewed as receivers of knowledge;	• Students are viewed as active constructors of knowledge;
• Students are teacher-dependent learners;	• Students move towards becoming independent learners;
• Learning is externally controlled, such as weekly quizzes and/or frequent tests;	• Learning is organized so that students have control over the learning, allows for self-regulation;
• Conflict and student errors are kept to a minimum;	• Students learn to deal with conflict and learn from their errors; that is, errors are viewed as part of the feedback system;
• Learning occurs through feedback of information given;	• Learning occurs through reflective abstractions, cognitive reorganization—sometimes with flashes of insight;
• Learning is viewed as linear;	• Learning is viewed as non-linear;
• Evaluation is linear, e.g., give four tests evenly spaced throughout the course and average them;	• Evaluation is loaded towards the end to allow for maximum benefits for the student;
• No direct accountability of setting standards;	• Accountability for setting standards—learners redo until they reach standards;
• Evaluation of teaching effectiveness is based on teacher's behaviors;	• Evaluation of teaching effectiveness is based on students' performance at the end.
• Does not account for baggage in students' starting place;	• Accounts for baggage in students' starting place;

Figure 1. Comparison between Model A and Model B (Flake, in progress).

curriculum and can support the development of critical thinking and problem-solving skills, then new teachers would come into their classes with a radically different focus for the use of technology to support their teaching efforts. Preservice programs need to provide more than instruction in how to use a filmstrip projector and an overhead projector. Understanding the wide variety of media available including telecommunication networks, computer databases, video discs and CD-ROMs will give the future teachers more access to data to aid in the research and development of tomorrow's already technologically literate students.

How do we know it works? With the advent of new educational technology programs and new national standards, comes the need to identify standards or benchmarks for tomorrow's students today. Teachers should be able to make the transition from the traditional "Type A" teacher to the student-centered "Type B" teacher. The student-centered teacher will be more inclined to utilize new educational technologies and relinquish the control of the learning task to the student. By accepting this role the teacher becomes less of an expert and more of a facilitator

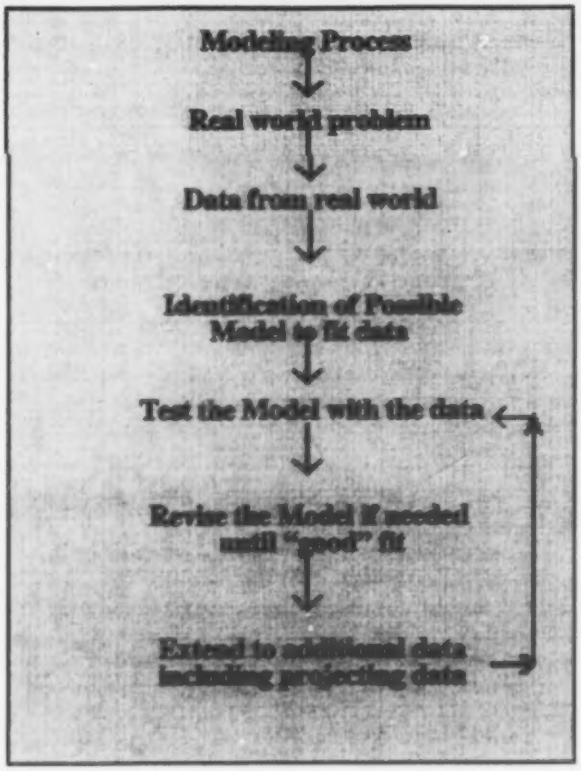
Modeling Process
Real world problem
Data from real world
Identification of Possible Model to fit data
Test the Model with the data
Revise the Model if needed until "good" fit
Extend to additional data including projecting data

Figure 2.

for the student to help guide his/her learning process. The students would also have a new role in the educational process. They would find more responsibility for their learning placed on their decisions and actions while learning to work with each other and their teacher in a more collaborative manner. If these criteria are met we should see teachers facilitating while students are questioning and exploring. Teachers would be continuing to learn side by side with the students they are teaching and students would take responsibility for their actions and personal development. Teachers and students would share their findings as they surf the Internet waves of information while planning together the next research project. Contacting experts in the field by means of telecommunications or reviewing a CD-ROM of pertinent data would be the norm instead of the novelty. This powerful scenario would introduce the educational system to a true community of lifelong learners. Teachers would be modeling techniques for students who are their collaborative partners. This is when we know it is working.

Conclusion

When considering the future of educational technology and its use in the Social Studies classroom, one must consider the changing needs of the society. If we closely examine the society of the future we will see the necessity of a technologically literate education community. The goal of the Social Studies has traditionally been to provide students with opportunities to learn their role as agents of change in their community and that their decisions should be thoughtful and worthy of an educated citizen. Tomorrow's citizens will need to understand the changing role of information technologies and how to master the techniques that make them powerful tools. Our teachers must then align their activities with such a society that allows for independent growth and maturation. We are still attempting to provide learning environments that foster civic minded adults, only now the means by which we introduce them to their potentials involves a modem and a keyboard.

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GRADUATE & INSERVICE

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Not long ago, less than a decade ago in fact, computers in education generally meant little more than a few Apple II or IBM XT PC computers that students in an "educational computing" or "AV Methods" course played with. Even then computers were useful in education, but times have changed dramatically. Today we're dealing with "information technology" rather than computers and that includes everything from CD-ROM and laserdisc materials to Wide Area Networks. And, as the diversity and uses for information technology have increased in teacher education, so has the need for training, staff development, and support. The papers in this section illustrate a number of approaches to meeting the training and support needs of teacher education.

Five papers describe inservice programs for practicing teachers. Some of these programs are tied to graduate instruction at a college or university. Gunter and Murphy, for example, describe how technology is being integrated into programs at Troy State University at Dothan and Sprague reports on work with graduate students at the University of New Mexico. Others focus on a particular school or district. For example, Wetzel, Chisholm and Buss describe a collaborative project between Arizona State University West faculty and a school district to infuse technology into the curriculum of elementary schools. With a similar purpose but different theoretical framework LeBlanc at Barry University also worked with teachers in one district. The four papers mentioned above all involve university faculty working in school districts. In contrast, Lemons' paper describes the teacher training work of staff in one of largest school districts in the country, the Houston Independent School District.

Projects like the ASU-West work involves ongoing relationships with teachers in selected districts. While desirable, that is not always possible. Carlson and Lambert describe how to make the most of a two-week summer institute for science teachers that was part of a NASA program.

Although almost all of the papers in this section describe projects, several emphasize particular components such as approaches to effective training (Robin and Miller), ways of encouraging the narrative mode of thought in a graduate course (Norton), alternative approaches to reducing the "pain" of graduate statistics courses (Dvorak, Willis, Tidler, and Martinez), software selection criteria (Persichitte), and practical suggestions for teacher educators who are incorporating computer technology into courses (Drazdowski).

Finally, there are four papers on the use of telecommunications for graduate and inservice work. Three papers (Johnson, Harlow, and Maddux; Scheffler, Betancourt-Smith, and Kirkwood; Wong and Smith) address ways of using the Internet. One paper, by Bradley, Holifield, and Bartels, describes the use of compressed video in distance education that involves the home campus and seven remote sites.

These fifteen papers provide a sample of: (1) ways teachers can be taught *about* instructional technology as well as ways (2) other content can be taught *with* the help of instructional technology. As you read these papers you will find a common theme - everybody wants to use technology effectively in education but few educators accomplish this today. These papers point to solutions - methods for preparing both this generation of teachers and the next for roles in technology-rich learning environments.

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An Evaluation of Project EXCEL Teacher Inservice Program

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John Goodlad (1983) observed that "the technological revolution appears to be sweeping around schools, leaving them virtually untouched." In school with high minority populations, this still remains true 11 years later. Chisholm (in press) found these schools have limited access to computers, a scarcity of good software and a scarcity of computer proficient teachers. Further, where computers are used in elementary schools, Becker (1986) found that the primary use of technology in science and mathematics continues to be drill and practice activities. Even schools that are providing both technology hardware and software resources and teacher professional development in the use of these resources find that changes in teaching and learning with technology are developing slowly. For example, the findings of a four year longitudinal study of the ACOT program (Sandholtz, Ringstaff, & Dwyer, 1991) indicated that the integration process was slow and teachers went through five developmental stages of classroom computer use: Entry, Adoption, Adaptation, Appropriation and Invention. Professional development opportunities for teachers appear to be one key to program success. In order for school-based innovations to work as planned, inservice opportunities and support for teachers must be consistent over time (Fullan, 1991). Finally, to make any difference, a necessary base of hardware and software must be available to teachers and students. The Office of Technology Assessment (OTA) (1988) reports that even as districts purchase more hardware, the student to computer ratio is still 30:1. This limitation prevents students from using technology to accomplish meaningful projects.

To improve the integration of technology into classroom instruction, the Creighton Elementary School District (ESD) developed a long range plan that provides teachers and students with technology and professional development. The district is located in the inner city of a large Southwestern metropolitan area and serves an ethnically diverse student population. A first step of this plan in 1991-92, included providing a computer for each teacher willing to take 45 hours of inservice in personal and instructional uses of technology. This offer was accepted by 130 teachers. The following year the Creighton ESD conducted a needs assessment of technology use in their schools. They found that only 10% of these teachers were actively using computer-based learning as an instructional strategy.. The Creighton ESD's findings are consistent with the literature cited earlier. As Goodlad and Chisholm indicated, technology was not making a big impact in the schools. Further, the school district estimated that most of the teachers who received the professional development were at the "entry" level of instructional uses of technology and concluded that a program of consistent professional development opportunities and support were needed over a period of three years.

In addition, the Creighton ESD survey revealed that teachers and their classrooms had access to computers for only 45 minutes per week. Consistent with the OTA report, the district discovered it needed more classroom computers and added computer labs to provide sufficient access for teachers and their students to create instructional projects.

The next step of Creighton ESD's long term plan, based on their 1991-92 needs assessment, called for the district to focus on the development of a high- intensity teacher training program. This program will integrate state of the art technology into the instructional process while increasing access to a technology-rich environment for students.

Overview of the First year of the Program

Goal and Objectives

The overall goal of Project EXCEL was to increase the academic achievement of students in mathematics, reading, writing, and science. This goal was divided into two primary objectives for the first year of Project EXCEL: (a) to accelerate the rate of integration of technology-based learning in the classroom; and (b) to prepare teachers to use multimedia technology for the production of instructional materials and units.

Participants

A collaborative model was used to implement the project. As a result, several different groups of participants played critical roles in Project EXCEL, including: teachers, a teacher-on-assignment (TOA), computer laboratory technology assistants, school principals, district administrative personnel, and students.. The project was implemented at two elementary schools in the Fall of 1993 when 23 teachers were selected from both schools to participate in the project. The collaborative model used a TOA, with demonstrated expertise in the field of technology, to: provide professional development experiences, aid in team development of curriculum units which integrate the use of multimedia technology, and facilitate the production of these units for distribution across the district and nationally.

The collaborative model brought together the multimedia expertise of the TOA and the curriculum expertise of classroom teachers while focusing on the academic needs of the students. Support for the program was provided by a technology assistant assigned to the 10-station computer mini-lab at each school. These individuals assisted the TOA to provide training for classroom teachers and were available to work with teachers and students on a daily basis. Principals and district personnel provided essential support to facilitate implementation of the project.

The Inservice Plan

As noted previously, the goal of the project was to influence student achievement by accelerating the rate of integration of technology in the classroom through a collaborative teacher training program, software development efforts, and installation of a 10-station computer mini-lab at two schools. From the district perspective, training in technology fits into a larger district goal of professional development for all district teachers. Thus, the district perceives development of technology skills as an integral part of staff development. Project EXCEL provides inservice training and staff development on a continuous basis.. This model is consistent with the literature which shows that one-shot or limited inservice does **not** provide for increases in the use of technology nor does it lead to systematic changes in instructional/learning processes in classrooms.

During the first year, the inservice plan for the project focused on providing extensive training to 23 teachers. Professional development sessions varied depending on the skills and needs of individual teacher participants. Examples of topics included word processing, spread sheets, databases, instructional software, CD-ROMs, and *HyperCard* for the creation of stacks. Additionally, a second component of the inservice plan of the project provided for the development of integrated units to be shared with other colleagues.

Teacher and Student Use of the Computer Labs

Teacher use of the labs was quite varied depending upon grade level and subject matter content. Teacher participants who taught younger students frequently used already developed software in their instruction. For example, *Story Book Weaver*, *ClarisWorks Word Processing*, and *KidPix* were used by several primary grade teachers to facilitate writing and illustrating of stories by their students. Teachers of intermediate grade students used more spread sheet and graphing types of software. By comparison, teachers of older students in grades 6-8 used materials they or their students developed in addition to using available software. For example, one teacher had her students develop stacks using *HyperStudio* to build lessons about women in history. Other teachers and students developed stacks about desert habitat and ecology and advising new students.

The labs were used by students and teachers for daily instruction. In addition, teachers and their students used the labs to develop projects before and after school and during their preparation and lunch periods. Teachers also used the labs to develop integrated instructional units.

On-site Facilitation

Essential participants in making the project a success were the TOA and the Lab Technicians. The TOA led much of the training and was available to assist teachers in the practice and use of the technology and in the development of the integrated instructional units. The TOA played an essential role of bridging from the technology to putting into practice the teacher participant's instructional and curriculum needs. The lab technicians were critical in the day-to-day operation of the project by responding to questions and trouble shooting problems that arose on a daily basis. The lab technicians also consulted with teachers to aid them in planning the class' use of the labs, software, and materials.

A critical component for integrating technology into the classroom is appropriate equipment and software. The grant provided funds to purchase equipment and software for a computer mini-lab at each school, Each lab was furnished with 10 computers and computer stations, printers and software programs appropriate to various disciplines and grade levels.

Methodology

Research Questions

The evaluators were asked to examine the effectiveness of Project EXCEL in terms of teacher training and classroom implementation of technology. The components of teacher training and classroom implementation that were evaluated included the effectiveness of inservice technology and instruction, the change of attitude towards technology use, and the degree of increased computer use for educational purposes. In addition, the school district requested that the evaluators look at teacher use of multimedia technology for the production of instructional programs and materials. The components evaluated were: (a) the development of instructional units using technology (b) the adequacy of project resources; and (c) the degree to which teachers shared program successes. These components are directly related to project goals, objectives, and outcomes.

Sample

Creighton ESD has an ethnically diverse student population. Some classrooms participating in the project consisted of English as a second language learners. Approximately 95% of the students at one participating school and 86% of students at the second participating school come from economically deprived families and have little or no access to technology in the home.

Participating teachers also encompassed a wide diversity in grade level and content areas. These teachers taught grades K and 2 through 8. They taught a range of content areas, from typical elementary program areas to bilingual academic content to specialized areas, such as art, music, library sciences, and counseling.

Procedure

Three Arizona State University West faculty members conducted the first year evaluation of Project EXCEL. Using several data collection procedures, the evaluators obtained both quantitative and qualitative data. The evaluators used both inferential and interpretative methods of data analysis. The data came from district survey instruments, personal interviews of varied participants, site visits, mini-lab observations, and the review of teacher-made technology-based instructional units. Data from site visits and observations provided a context for reporting project outcomes. The extensive review of teacher-made technology-based instructional units provided data on the products resulting from Project EXCEL training and collaborative curriculum development processes.

The evaluators conducted interviews with 23 teacher participants and reviewed 19 teacher-made instructional-based units. Survey data included teachers' initial and end-of-year attitudes toward technology and extent of use. In addition, the evaluators interviewed the school principals from the participating schools, the mini-lab technology assistants, the TOA, and various district administrators associated with the project.

Results

Teacher Technology Training

The workshops were quite effective in enabling teachers to use the technology. Teachers perceived the staff as very supportive and instrumental in their learning and use of technology. The interviewed teachers indicated a need for additional training on databases and *HyperCard* so that they could use these programs in designing their instructional units. The teachers also indicated that the TOA was both supportive and a critical link to their success in implementing technology for teaching and learning, as well as in developing their instructional units. Data from the mini-labs also attest to the effectiveness of the teacher training. Demand for lab time went well beyond the available time. Consequently students used the lab both before and after school and during lunch time.

Teacher attitudes towards Project EXCEL were positive. A pre- and post-test on a 12 item questionnaire showed significantly higher score on the post-test. Teacher interviews corroborated these data. Sixteen of the teachers interviewed said they were comfortable using computers in their classrooms. Nevertheless, these teachers expressed a need to learn more. Teachers felt comfortable using word processing, drawing programs, and, for some, CD-ROM resources. Only 5 of 16 teachers indicated they felt comfortable using or teaching *HyperCard* to their students.

On the ACOT Scale, teacher self-ratings of computer use for educational purposes increased for 18 of 21 teachers. By the end of the first year, 18 teachers felt they were at an Adaptation or Appropriation level of technology use. A strong sense of developing competency emerged in these self-reports. However, ratings of curriculum units by the evaluators reflected a slightly different picture. Seven of 15 thematic units exhibited some form of Adaptation or Appropriation. Nevertheless, these achievements are commendable for the first year.

Development of Instructional Units

The teacher-made instructional units demonstrate substantial effort. The units span grades K through 8 and represent a range of topics and areas: art, music, science, geography, environmental awareness, criminal and civil justice, leadership, global awareness, and social sciences. They incorporate an array of software and electronic resources and a wide range of learning activities, such as creative writing, generating artistic creations, researching and gathering information, recording and graphing data, and preparing slide shows and multimedia presentations. These units exhibit various levels of technology use. Some units were more integrative in nature than others. Although the units were based on district-wide objectives, teachers did not state these objectives explicitly.

The resources available, including lab space and computers, are minimally adequate to meet the needs of the project. Demand for lab space and time are severely strained given the existing resources. On the average students received 20 to 75 minutes of computer time per week. The software collection, though small, is adequate and appropriate given the project has been underway for only a year. Moreover, the software is appropriate for elementary school settings, though some is linguistically difficult for limited English proficient children. The software is also consistent with the goals of the project.

In general, the staffing for Project EXCEL is appropriate. The presence of a technology assistant in each mini-lab was critical to the success of the project. Administrative support at the site and district levels contributed substantially to the success of the project. However, some teachers noted that they did not always feel they had the support they desired or need because the one project TOA served 23 participating teachers at two school sites.

Through the teacher interviews, it became clear that teachers did not have appropriate opportunities to share their successes with other colleagues. Workshops provided opportunities to learn skills and use programs. However, there was little time for participants to share their project success and ideas. What limited sharing occurred resulted from informal communication among teachers.

Conclusions and Recommendations

The inservice development model underlying Project Excel is exemplary. It provides for inservice training and staff development on a continuous basis. This model is consistent with the literature which shows that one-shot or limited inservice does not engender increased technology use nor lead to systematic changes in the instructional/learning classroom processes.

Overall, the inservice teacher technology training met the goals of Project EXCEL. Teachers learned to use the hardware and a variety of software. However, we suggest that during Year 2 of the project, teachers focus on developing expertise with databases and *HyperCard*. Moreover, HyperCard training should be restricted to teachers with some expertise in computers and software use because *HyperCard* requires some degree of familiarity with the computer. There was a discrepancy between how many teachers rated their use of technology and the evaluators' ratings. It seems appropriate to offer teachers clarification on the developmental levels and the characteristics of varying technology integration.

Project staffing and support were very strong. Teachers perceived the staff as supportive and critical in their learning and use of technology. The TOA played a critical role in classroom implementation and the development of computer-based instructional units. Because the TOA works with teachers at two schools, one TOA is not enough. As a result of the evaluators' recommendations, in Year 2, the project employed a second TOA. Each school has a team consisting of a full-time TOA and a full-time technology assistant who provide support and assistance to participating Project EXCEL teachers.

Resources in the mini-labs were minimally adequate. There were not enough computers in the lab to accommodate the number of teachers and students. We see this as a concern, and recommend a better balance between project resources and the number of participating teachers. As a result of this recommendation, in Year 2, each of the schools acquired five additional computers to better meet the demand. One school moved the lab into a larger room that more adequately meets the project's needs.

The instructional units showed significant time commitment by teachers. The units did not explicitly state district-wide objectives. We recommend that these objectives be stated in the future so that the units clearly demonstrate their incorporation. Further, many units neither adequately integrated technology nor content areas. We feel teachers need more training in the development of integrative units that incorporate content areas and weave technology into the teaching/learning process.

Sharing of instructional technology successes is essential to maintaining interest and motivation among participant teachers and non participants at each school. Through sharing teachers learn from each other and experience the excitement of doing something that works well with their children. During Year 2, the TOAs have set aside times for teachers to discuss their successes and ideas during the training sessions.

Project EXCEL attained an exceptionally high level of success during the first year. All of the major outcomes for Year 1 were attained or exceeded. Teachers' and students' attitudes toward the project were very positive and teacher use of computers for instructional purposes grew substantially. Based on the first year evaluation report, the district has implemented new procedures that will strengthen the project during its second year. These new procedures include:

1. more carefully specifying the criteria for the development of thematic units;
2. more careful alignment of district objectives and unit objectives, classroom instruction, integration of technology, and assessment;
3. and limiting the number of participants to assure optimal use of resources.

These new procedures in combination with the provision of additional computers, the hiring of a second TOA, and offering time for sharing of instructional successes, should strengthen this effective program.

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Teaching Teachers to Teach with Technology: A New Program

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Teachers in the nation's schools are charged with teaching students who will spend most, if not all, of their adult lives in the twenty-first century. The computer, as a leading technological device, is expected to be a major force in the restructuring of school systems (Hodas, 1993; Sheingold, 1991). Yet, many of these teachers report little knowledge of or the ability to use computer technology. The discrepancy that exists between what teachers know and what students must learn about technology represents a complex issue, even though computers have been available in schools throughout the nation for years (Lockard, Abrams, & Many, 1990).

Technology is a rapidly developing and changing phenomenon, resulting in great challenges and changes for educators and education. Zappone (1991) reports that "despite the increasing number of computers in schools there has been minimal significant impact in the revitalization and transformation of teaching and learning" (p. 83). Teachers have had little more than "cursory experiences using new technology in the classroom" (Brady, 1991) and have been involved in insufficient professional development/inservice activities regarding effective classroom usage.

Background

In 1985, Becker collected data on school-based computing which was analyzed by Gail Marshall. Marshall (1987) concluded that "despite the million computers now in U.S. schools, only 25% of the teachers in those schools say they use the computer regularly" (p. 41). Of this group of teachers who use the computer regularly, only "10% of the elementary teachers think of themselves as expert" (Marshall, 1987).

The lack of technical expertise shown by the teachers extends from those teachers who have just entered the profession to those already in the field. A 1987 American Association of Colleges for Teacher Education survey found that only 30% of student teachers felt they were able to integrate computers in the instructional process (Nuccio, 1990), and a more current Office of Technology Assessment study substantiates these findings by reporting that less than one-third of the education majors surveyed felt they were prepared to teach in the classroom with computers (Olson, 1992). Brownell and Brownell (1991) call for preparatory programs to integrate the use of the computer in methods classes and field experiences so that the students will use the computer once they become in-field teachers.

Revenaugh (1989) believes that the teacher's role in computer integration is the "key to optimal computer instruction." This lofty description of the role of the teacher is reiterated by LaFrenz and Friedman (1989) who argue that if computers are to function as an integral part of the teaching and learning process, "the teacher--the most complex variable in the solution--is the key ingredient."

Following two years of research, the Center for Technology in Education (1990) notes that one question still to be answered is "how does the teacher become expert with the technology and learn to incorporate it into his or her teaching?" If teachers are to effectively integrate the computer in the instructional process, they must achieve a level of computer competence that supports their ability to use the computer. They must understand the teaching processes that can be enhanced by using the computer and acquire evaluation skills for determining when to use the computer and assessing the effectiveness of the computer when it is used in the instructional scheme (Hurst, 1994; Murphy, 1993).

Teachers must be familiar with the hardware and software, as well as their content objectives, to be able to fulfill this kind of effective integration of the computer. Yet, as Young (1991) observes, teachers are not effectively integrating the computer into the instructional process, even though computers are available to the teachers. In her observations, she notes "little difference in the way teachers teach and students learn even though computers and related technology have been available in schools throughout the eighties" (Young, 1991). Young maintains that the education of teachers must include access to the use of computers "to give teachers time to explore and practice so that they may learn how and when to use technology in their classrooms."

Sales (1990) notes that preservice and inservice training efforts have been unsuccessful and highlights the 1987 Office of Technology Assessment report that stated that less than one-third of teachers in classrooms have had more than ten hours of computer training. The 1989 IBM nationwide survey of computers concluded that a lack of training is one of the major barriers to effective computer usage (Wirthlin Group, 1989).

In 1987, a study by Woodrow (1987) resulted in her urgent call for inservice and preservice training. Heck (1990) notes, however, that teachers who receive training do not automatically use the computers nor do they use the computers for varying purposes. If teachers are to successfully integrate computers into instructional exercises, they must be familiar with this technology (Curtin, et al., 1994).

Teachers will use the computer if they gain this familiarity and understand "how, when and where to use it" (Young, 1991). The question arises as to the amount of computer knowledge teachers must possess to be able to effectively integrate computers into the instructional process. Sales (1990) recommends "computer training for teachers should emphasize strategies for successfully integrating computers into instruction." Teachers must become proficient in computer use and effective integration of technology in the curriculum if student learning is to be enhanced with competent integration of technology.

If the students of this nation are to prevail in the twenty-first century, American schools are going to have to respond more effectively to the challenge of preparing students to be technologically literate in the sense of being able to use the computer across the spectrum of living and learning (Gunter, 1994). The former Secretary of Labor, Elizabeth Dole, formed the Secretary's Commission on Achieving Necessary Skills (SCANS) for the purpose of determining the appropriate foundational skills and competencies necessary for successful career performance across diverse professions (U.S. Department of Labor, 1990). The SCANS report indicated that education must provide students the ability to use resources, information, and technology (Riel, 1993). These commitments reflect an acceptance of technology into the curriculum and denote a strong commitment from our government agencies for the necessity of these programs (Whetzel, 1992).

The restructuring schools theme has been a forum of recent education discussions and includes an emphasis on advanced and emerging technology to move students from the industrial age to the information age/communication age. Noting the technological revolution/evolution, calls for schools to change their curriculum to reflect that current and emerging technologies are being initiated.

Alabama's Response

As a response to these calls and the substantiated need for the integration of technology, the Alabama State Department of Education and the Alabama Commission on Higher Education (ACHE) began the Technology Scholarship Program for Alabama Teachers (TSPAT) in 1993. Alabama Act 636 was passed in May, 1993 to legislate this innovative statewide program. The TSPAT program requires that participating training institutions establish coursework that meets three general standards:

- instruction will utilize both Macintosh and DOS platforms
- three technology courses will be taught sequentially, and,
- evaluation of training programs will be based on assessment of student products and performance.

The Association for Supervision and Curriculum Development (ASCD) has encouraged school systems to develop strong technology plans, programs, and curricula for future educational endeavors (Cawetti, 1989). Acknowledging that a properly developed educational technology curriculum and technology plan may hold answers to educational dilemmas, Troy State University at Dothan (TSUD) has enhanced the TSPAT program to include a stronger emphasis on planning and integration.

The purpose of this program is to provide teachers with a supportive educational background in the use of technology and authentic experiences necessary to promote the effective integration of these technology skills into the curriculum. This commitment receives extensive and continuous support from the university as is acknowledged in the recent General Statement from the Institutional Technology Planning Committee that stated that there would be a direct correlation between the growth of TSUD and its commitment to technology. The three course sequence of the TSUD program is designed to equip teachers with the necessary skills by providing expert instruction and sophisticated technology to support the instruction.

The TSPAT program is designed to cover direct educational costs (tuition and mandatory fees) for all eligible teachers in the state of Alabama. All advanced degree programs must begin with three sequential courses offered in educational technology which serve to front-load the degree sought by the student and paid for by ACHE. After completion of the three technology courses, ACHE will continue to provide the funds for each teacher to complete a Master's degree in the allowable fields of study. This program, which applies to certified public school teachers in the state of Alabama, includes the integration of technology skills in the curriculum. This integration is defined as the use of various technologies to restructure and enhance the day-to-day teaching and learning process. Restructuring the teaching and learning process encompasses computer-based instructional technologies, current and emerging instructional technologies, and curriculum integration of technology.

The educational program at TSUD is dedicated to the preparation of individuals for competent computer-based multimedia instructional decisions. The program provides graduate students with the opportunity to construct knowledge and refine practice through experiences which support informative, reflective decision-making. The three core technology courses cover integrated software packages, desktop publishing, multimedia, hypermedia, telecommunications, optical technology, planning curriculum integration, and the planning and design of curriculum with computer infusion for use in all teaching environments.

Recognizing that the introductory computer course is fundamental to a student's success with computer technology, TSUD designed the initial TSPAT course to meet the unique needs of the novice teachers. Specifically, the course is designed to present the technology in a non-threatening and engaging manner so that the initial experiences with the computer are successful and serve as a foundation upon which subsequent and more difficult computer experiences are established. The first course is dedicated to the preparation of individuals with basic computer skills and the integration of the technology into all learning strategies. Instructional processes, traditional and innovative delivery systems, and the use of technology and instructional design will be explored.

The purpose of the second course is to prepare students to become competent, aware and responsive to current and emerging instructional technologies. Further, the course provides the graduate student with the opportunity to construct knowledge and refine practice through experiences which support informed, reflective decision-making. Logical and theoretical knowledge for a working competency of software and applications of new and emerging technologies is presented. Opportunities are provided to develop a working knowledge of desktop publishing, computer graphics, hypermedia, telecommunications, and optical technology. Additionally, teachers assess technology for use with students who have special needs.

The major emphasis of the third course is to refine the experiences of the teachers to prepare them to effectively infuse the learned technology skills and knowledge into the curriculum design and planning process. Students are provided with opportunities to plan for curriculum integration, design instruction with computer integration, demonstrate instructional production techniques, and design and evaluate educational software.

In 1993, TSUD successfully implemented this program with 80 service area teachers and is currently working with 78 additional teachers. In support of the mission of the university and the continued integration of technology, TSUD has enhanced the program to include follow-up study with the students and consultations with schools and school systems who have teachers participating in the program so as to foster the effective decision-making of the teachers.

Budin (1991) contends that teachers must become decision-makers and receive training allowing them to not only use educational software that compliments their curriculum but gives them the knowledge about technology to make meaningful decisions about the potential of computers and their usage in the classroom. Budin provides a historical review of the evolution of the role of the teacher as a mere manager of computer instruction.

Many states will continue to invest billions of dollars in the latest hardware and software, but their goals and measurable educational improvements will continue to fall short unless schools realistically invest in their most important resource, their teachers (Peck & Dorricott, 1994). Troy State University at Dothan's new TSPAT program is designed to empower Alabama's most important resources for education, Alabama's K-12 teachers.

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ITS Changing Teachers' Paradigms

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Over the past ten years, technology has been predicted to be the savior of an educational system in need of reform (National Commission on Excellence in Education, 1983). And yet, despite the fact that 99% of all elementary and secondary schools in the United States have computers and that 93% of students use these computers everyday, American students are less computer literate than their European counterparts, and American teachers receive less computer training than teachers in Europe or Japan (Siegel, 1994).

Despite this apparent lack of training, the responsibility for failure to incorporate technology into the schools is frequently placed on the classroom teacher. Yet, this failure does not belong with the classroom teacher alone or even with technology itself. Teachers' use of technology often forces it into traditional teaching paradigms that have existed for decades. Teachers and educational reformers rarely recognize that innovative uses of technology require a revision of educational practice if technology is to impact the American education system.

The reason technology, and other reforms, so often fail is because education is a self-replicating system. New teachers entering the system bring with them the same beliefs as their predecessors (Norton, 1994). These beliefs or paradigms are the result of 17 years of experience in the current American system, and it is frequently difficult for teachers to challenge their existing paradigms. Thus, they continue to teach the way they were taught. Teachers need to experience alternative teaching strategies as part of their own learning. These experiences may then precipitate paradigm shifts in their perception of the teaching/learning process. Research on teacher development suggests that paradigm shifts are more likely to occur among inservice teachers than preservice teachers (Katz, 1972, Norton, 1994). It is likely, therefore, that it is within graduate teacher education programs that we may best answer the question, how can technology be used to reform an educational system in crisis?

ITS Program

Schubert (1986, p. 371) asserts that the professional educator is "the most salient force in the curriculum improvement process" and that the most important aspect of curriculum improvement is professional development. He states that for inservice teachers, graduate programs need to focus on the needs of the teachers as well as be cohesive and integrated. Such programs should be oriented toward the utilization of research and practical knowledge and take into account the experiences of the teachers. Graduate teacher-students must be supported in learning that a "teacher is a leader from within, not a dictator (no matter how benevolent) from without" (Doll, 1993, p. 168).

In order to meet this challenge, the College of Education at the University of New Mexico began an innovative graduate program, Integrating Technology in the Schools (ITS), in August 1993. The ITS Program is structured around a cohort group of 48 participants. Students in the Program start and finish together. Once a Program cycle has begun, no one else is allowed to join. By structuring the

Program in this manner, the instructors eliminate the need for students to find common ground at the beginning of each semester. Since students are together for four consecutive semesters, they share a common set of experiences, knowledge, readings, activities, and support systems (Norton, 1994). They also share a common area of inquiry, one that centers around the models, methods, and processes which might support incorporating technology into the educational process.

There is a need for educators to think about knowledge as more than the acquisition of facts related to a particular domain of inquiry. Knowledge needs to be viewed as a complex web of inquiries framed by a problem. In order to meet the challenges of complex problems and systems, the ITS Program is designed around a transdisciplinary curriculum. The group explores topics holistically, jumping from one topic to another. Students move forward to new levels of understanding and backwards to revisit prior areas of inquiry.

The ITS Program focuses on four, broad domains of inquiry:

1. *Technology Impacts on Social Contexts* through exploration of the history of technology, role of technology in society, the psychological impacts of technology, technology integration as it impacts different cultures, and the ways technology can become a vehicle of change in the educational process;
2. *Technology Impacts on Knowledge Forms* through examination of the epistemological influences of technology on the nature of knowledge by examining the structures of the various discourse forms created by electronic technology;
3. *Technology Impacts on the Learning Process* through the exploration of various learning environments and the investigation of newer visions of the learning, thinking, problem-solving process including the nature and role of instructional strategies; and
4. *Technology Impacts on Educational Goals* through the reassessment of traditional educational goals, rethinking what learning is, how students learn, the nature of each learner's cultural and social experiences and how they impact learning, and how learning can be assessed (Norton, 1993; Norton, 1994).

Telecommunications plays a major role in the ITS Program and provides a mechanism for promoting group study and group inquiry. Through various online activities that transcend the two groups, one cohesive group forms. Online communication provides the means for group support, collaboration and study. Participants access telecommunications through either existing College of Education Microcomputer Labs, through computer systems at places of employment, or through personal computer systems. Use of asynchronous communication allows members to discuss ideas and concepts and collaborate on projects without the necessity of standardizing time and place. Members are able to access telecommunications at their convenience, thereby causing minimum disruption in their family and professional obligations (Norton, 1994).

Methodology

Design

This study investigated the effects of the ITS Program on a group of inservice teachers' self-reported use of a variety of instructional strategies, their perception of the effectiveness of those strategies, and their stages of concern related to the integration of technology as a change or innovation. An ex post facto survey/interview design was used.

To implement the ex post facto design, the study surveyed the 1993-94 ITS group which was in the process of completing their fourth and last semester and the 1994-95 ITS group which was just beginning their course of study. For the 1993-94 group, the surveys were sent through the U.S. Postal Service. Self-addressed, stamped return envelopes were included to insure a high return rate. For the 1994-95 group, surveys were distributed during the first class meeting during the first semester. The surveys were taken home, completed, and returned the following week. All statistical tests were performed using an alpha of .05.

Subjects and Treatment

Subjects were 96 graduate education students from a large southwestern university; 48 had participated in the 1993-94 Program and 48 were participating in the 1994-95 Program. Subjects are practicing teachers. In each year's group, 24 participants were from a large metropolitan school district and 24 were from smaller rural school districts.

All subjects had been chosen to participate in the ITS Program. Subjects had applied and were accepted for participation in the 1993-94 Program. In June of 1993, fliers advertising the ITS Program were sent to public schools throughout the state. Several informational meetings were held to explain the ITS Program, answer questions, and distribute applications. Completed applications, letters of recommendation, and transcripts were submitted through the established University admission policy. A six-member panel reviewed and rated each application. During the planning phase of ITS, it was determined that available personnel and technology resources could support 48 participants. Based upon the ratings of the reviewers, 24 educators were chosen to form one cohort group in the northern part of the state and 24 educators, centered around the state's major metropolitan area, were chosen to form the second cohort group. The 1994-95 participants were selected using the same process and within the same programmatic limits.

All ITS participants are full-time teachers and most have family obligations. The ITS Program is structured to complement rather than disrupt their work. During each cycle, 24 educators meet at a school equipped with appropriate technology resources located in the northern part of the state. The other 24 educators, centered around the state's major metropolitan area, meet at the University and use the technology resources available there. Each group of 24 meet independently one night a week for five hours. They meet jointly one Saturday a month for eight hours. In addition, a large portion (between a fourth and a third) of the groups' inquiry process is facilitated by telecommunication activities, with both groups sharing in projects and discussions (Norton, 1994).

Instrumentation

All 96 participants (both ITS groups) received a packet containing a cover letter describing the purpose of the study, a demographic sheet, an instructional strategy questionnaire, and a questionnaire assessing teachers' stages of concern related to the integration of technology as a change or innovation. The demographic sheet provided the researcher with background information about the participants.

Instructional Strategies Frequency and Effectiveness Inventory. The Instructional Strategies Frequency and Effectiveness Inventory (ISFEI) was developed by Alexander (1988) to determine how teachers teach. The original inventory consisted of 35 survey items rated on a 4-point Likert scale and representing a sample of various instructional strategies and techniques. The strategies are organized into five categories: Student-centered, Teacher-centered, Process-oriented, Content-oriented, and Generic (Harvey, 1991). Participants rate each item for Frequency of Use (from Seldom Never to Usually) and for Effectiveness (from Very to Not). Effectiveness is rated even if the participant rates Frequency of Use as Seldom or Never.

The ISFEI was modified to include strategies specific to science and the use of information technology strategies in the classroom (Harvey, 1991). It was further modified for this study by randomly distributing the information technology strategies throughout the Inventory rather than clustering them at the end of the inventory.

Stages of Concern About an Innovation Questionnaire. In order to assess the level of teachers' stages of concern related to integration of technology as a change or innovation, the Stages of Concern About an Innovation Questionnaire (SoCQ) was administered (Hall, George, & Rutherford, 1979). The instrument is based on a seven stage developmental model: (0) awareness; (1) information; (2) personal; (3) management; (4) consequence; (5) collaboration; and (6) refocusing (Hall & George, 1979). The SoCQ consists of 35 questions, each designed to reflect concerns relevant to the seven stages of the model. Respondents rate the degree to which each item reflects their feelings about a change or innovation using an 8-point Likert scale which ranges from "Irrelevant" (0) to "Very true of me now" (7). A cover sheet is included which explains the purpose of the questionnaire and provides directions. The SoCQ can be administered individually or in a group. It has also been administered successfully by mail (McNergney & Carrier, 1981).

Results of Study

To determine the impact of the ITS Program on participants, a group nearing the end of the Program was compared with a group just beginning the Program. The groups were considered comparable on the basis of similarity of selection and their expressed desire to participate in the Program. The 1993-94 and the 1994-95 ITS groups were compared using the demographic information provided by the participants as part of the survey process. Of the six areas compared, four had no significant differences (Table 1). The 1993-94 group had significantly more males than the 1994-95 group. The 1993-94 group had significantly more Middle School teachers. It was felt that the two areas determined to be significant, Gender and Grade Level, did not jeopardize the viability of comparing the two groups.

Table 1
Demographic Information

	1993-94	1994-95	Chi-Square	*p*
Gender				
Male	13	4	6.14	.013
Female	25	34		
Ethnic				
Hispanic	5	5	2.30	.806
Anglo	29	28		
Other Minorities	4	3		
Degree				
Masters	29	28	.004	.948
Ed. Specialist	9	9		
Marital Status				
Single	6	5	4.55	.103
Married	29	23		
Divorced	3	10		
Have Children				
Yes	23	26	.060	.807
No	13	12		
Grade Level Teaching				
Elementary	14	21	7.86	.049
Middle	15	5		
High School	9	11		

On the Instructional Strategies Inventory, Frequency of Use of Technology as an instructional strategy was found to be significant (Table 2). The 1993-94 group reported a significantly higher usage of technology in their classrooms than the 1994-95 group. No other area was significant. On the Stages of Concern About An Innovation, two areas were significant (Table 3). The 1994-95 group scored significantly higher on Stage 0 (Awareness). A high score (Very true of me now) on items such as "I don't even know what the innovation is," "I am not concerned about this innovation," "I am completely occupied by other things, although I don't know about this innovation," "I am concerned about things in the area," and "at this time, I am not interested in learning about this innovation" reflects concerns at the Awareness Level. The 1994-95 group mean reflects that these concerns are more true of this group than of the 1993-94 group. The 1993-94 group scored significantly higher on Stage 6 (Refocusing). A high score (Very true of me now) on items such as "I now know some other approaches that

Table 2
Instructional Strategies Frequency and Effectiveness Inventory

	1993-94 Mean	1994-95 Mean	*t Value*	*p*
Frequency of Use				
Teacher-Centered	2.46	2.53	-.66	.514
Student-Centered	2.67	2.83	-1.29	.203
Content-Oriented	2.19	2.21	-.34	.735
Process-Oriented	2.92	3.08	-1.56	.124
Technology	2.15	1.67	4.13	.0001
Effectiveness of Use				
Teacher-Centered	2.94	3.03	-.99	.328
Student-Centered	3.29	3.44	-1.43	.158
Content-Oriented	2.81	2.90	-1.18	.241
Process-Oriented	3.32	3.43	-1.22	.226
Technology	3.00	3.04	-.19	.849

might work better," "I am concerned about revising my use of the innovation," "I would like to revise the innovation's instructional approach," "I would like to modify our use of the innovation based on the experiences of our students," and "I would like to determine how to supplement, enhance, or replace the innovation" reflects concerns at the Refocusing Level. The 1993-94 group mean reflects that these concerns are more true of this group than of the 1994-95 group.

Table 3
Stages of Concern About an Innovation

	1993-94 Mean	1994-95 Mean	*t Value*	*p*
Stage 0: Awareness	1.29	2.09	-3.61	.001
Stage 1: Information	4.01	4.58	-1.72	.09
Stage 2: Personal	4.24	4.42	-.42	.675
Stage 3: Management	3.50	3.47	.08	.933
Stage 4: Consequence	5.37	4.95	1.39	.169
Stage 5: Collaboration	5.86	5.23	1.89	.063
Stage 6: Refocusing	4.48	3.28	3.68	.0005

Discussion

This study was designed to assess the impact of a cohort, graduate program for inservice teachers which focused on the integration of technology throughout the educational process. Through an emphasis during the program of study on technology as a vehicle for innovation and change, teacher-students examined the integration of technology as it might impact an integrated, problem-centered curriculum, as it might promote process-oriented learning, and as it might support collaborative, student-centered strategies. The relatively high means reported by both groups in favor of both frequency of use and perceived effectiveness of this approach to learning suggests that those who self-select to study the integration of technology are already predisposed to these strategies. Thus, it is not particularly surprising that no significant differences were found between the two groups. If, on the other hand, these teachers were to be compared to a randomly selected group of graduate teacher-students, differences might emerge. The same argument holds true for the perceived effectiveness of a variety of information technologies. Those who choose to study the integration of technology come to their studies with a perception of the importance of these technologies.

The participants rated the effectiveness of each strategy on a 4-point Likert scale based on the following terms: "very," "rather," "poor," and "not." Both groups reported their perception of the effectiveness of a variety of information technologies as "rather." The 1993-94 group reported their use of a variety of information technologies as "sometimes" while the 1994-95 group reported their use of a variety of information technologies as "seldom/never." While a discrepancy between belief and practice continues to exist, the discrepancy for those completing the ITS Program has diminished. The fact that significant differences were found between the two groups on the frequency of use of information technologies suggests that the Program was effective in enabling these teachers to turn their perceptions into practices.

Results on the SoCQ are equally informative. The significantly different means on the Awareness Level with higher means for the 1994-95 group and the Refocusing Level with higher means for the 1993-94 group suggest that the ITS Program had a significant impact on shifting teacher-students' concerns from personal impacts and insecurities to global and systemwide impacts and potentials. The means for the two groups show a clear trend for participants in the ITS Program to shift toward increasing interest in and concern about student consequences, collaborations with peers, and reassessing educational practice as it relates to the integration of technology. While not a stated goal of the Program, the data reflects that the cohort process not only promotes knowledge about the integration of technology as an agent of change and innovation but also promotes a growing interest in leadership roles as they pertain to educational change.

The results of the surveys represent the first phase of this research. The second stage is currently underway. During this stage, the 1993-94 ITS participants who completed their studies in December 1994 are participating in online dialogues with the researcher centered around the following questions: What transformations do these teachers identify within themselves, what factors do these teachers identify as being influential in their changing, what changes do these teachers describe in their professional practice, and what professional activities are these teachers involved in now that they were not involved in before the ITS Program? Through these online dialogues, it is hoped that it will become possible to identify those activities, practices, readings, and projects which account for these participants' increased use of the information technologies and for their shift from personal to professional concerns.

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Teaching Elementary and Middle School Teachers about Technology: An Example from NASA

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With the growing concern about students' skills, the U.S. has experienced a dramatic growth in the use of computer-based technology for instructional purposes. By 1991 more than 3.5 million computers had been installed in the nation's more than 17,000 school districts (Software Publishers Association, 1992). Yet many teachers are reluctant to use the technology resources available to them due to lack of training and experience. To address this need, NASA Langley Research Center (NASA LaRC), in response to Executive Order 12821 which mandates more emphasis on science education, developed a two-week long Teacher Enhancement Institute (TEI) to give teachers hands-on training in educational technology (ET). Two TEI sessions were held in the summer of 1994. This paper describes the design, implementation, and evaluation of the educational technology portion of the Teacher Enhancement Institute.

Goals and Constraints

In order to accommodate NASA LaRC's dual goals of exposing teachers to aeronautics and to educational technology, approximately 30% of the contact time and 50% of the course development effort were invested in the ET portion of TEI. When designing the educational technology, goals and constraints that needed to be met included:

1. in order to be interesting and relevant, the course was designed to be immediately useful to the teachers;
2. in order to develop a vision of what ET could incorporate, the teachers were exposed to a wide variety of ET;
3. for theoretical and pedagogical reasons, the course was designed to be hands-on;
4. in order to internalize the new concepts and skills that the teachers were learning, they would have to practice them over an extended period of time; therefore, the course was designed so that the teachers would continue to be actively involved in the learning process after the two weeks were over;
5. because the entire TEI included instruction in aeronautics and in incorporating all of this material into the classroom, a limited amount of instructional time was available for educational technology, so the course was designed to be intensive;
6. because there were only ten computers and 20 teachers (per session), the course had to be designed so that two teachers could share one computer;
7. because this was a new initiative, it was particularly critical that the impact of the project on the teachers and on the schools be measurable;
8. because the course was being taught at a national laboratory with substantial technology resources, the designers of the course wanted to make maximum use of the resources available at NASA LaRC;
9. because the teachers came from a variety of backgrounds (40 K-8 teachers, with an even distribution across the grades; 19 were experienced teachers; 21 were inexperienced, and each came with a different background in technology), the course had to be flexible and appeal to teachers from these varied backgrounds; and

10) because the teachers were being given graduate credit for this course at Christopher Newport University, the course had to be rigorous enough and include the training necessary to complete the required project, which was the development of an instructional module to be applied in their classroom.

The facilities to be used were state of the art and placed in a room created especially for TEI. Hardware included ten Macintosh PowerMac 6100/60 computers which were connected to the Langley research network and were each separate Internet nodes. A variety of software was available, including ClarisWorks (discussed below). Other hardware available for use in the technology classroom were laser printers, a color scanner, a large screen TV, a video playback unit, a video recorder, a digital camera, and a laser disc player.

Lessons Chosen and Rationale

The lessons were designed to achieve the goals and to accommodate the constraints. Approximately 21 hours were allotted during the two weeks for educational technology instruction. One of the interesting results of the program was that whenever there was time not otherwise scheduled, teachers chose to spend it on ET. In general, then, the TEI participants received several hours more technology exposure than the syllabus listing.

All lessons (except the educational television one) were taught in the computer classroom created for TEI. Lessons were participatory; the instructor would explain a technique, then ask the teachers to try it. The sessions emphasized application to the classroom and classroom planning. Between sessions, teachers had time to practice independently. The different backgrounds of the teachers meant that a great deal of personal attention was required. Therefore, in addition to the instructor, at least two other individuals familiar with the material were available for every lesson. Much of the class time was spent in individualized instruction or talking to small groups of two, helping them to master a particular skill that supported each lesson objective. Two instructors were available to help answer questions during practice sessions. This ratio allowed a great deal of learning to take place in the small amount of time given. Short projects were given to the teachers in each lesson to help them assess their own progress.

Syllabus

The lessons were designed to provide the teachers with a balance between the breadth of information about educational technology which fulfilled the 'vision' goal (goal 1 above) and system specificity, a measure of usefulness (goal 2 above). For example, the library and digital technology sessions gave teachers a vision of what can be done; "libraries of the future" were discussed and demonstrated in the library session, and CDs, digital photography, full-motion digital video, and scanners were used in the digital session. Many of the teachers did not have access to this material in their schools (though some did), but they did become familiar with it and were able to use it. During a more immediately applicable session, the local PBS station presented its fall schedule, its summer and fall workshops for teachers, and showed ways that the programming could be incorporated into the classroom (because all teachers were from the area, one PBS station serves all of the schools where the teachers teach).

Table 1 shows how the 21 hours were distributed and sequenced.

Table 1
Educational Technology Syllabus

Hours	Topic spent
1.0	Educational technology from a systems perspective - what is it; what are its goals; and what are the goals of TEI;
2.0	ClarisWorks - how to use an integrated word processor, database, spreadsheet, painting, drawing, and communications package;
2.5	Text-based tools available on the Internet - Gopher, E-mail, anonymous FTP, Archie, and Telnet;
2.0	The World Wide Web and Mosaic - an overview;
1.5	Technology Application - computers in one classroom
1.5	Technology Application - computers in one research lab
2.0	Educational television - where we are and where we are going
1.5	The library as an online reference - examples from a library without walls
1.5	Digital technology - including CD-ROM and digital photography
1.5	Educational technology wrap-up
4.0	Individual Practice Time
21.0	Total Hours

Another example of the visionary/pragmatic division is the choice of applications that were presented. An area teacher who is currently using the Internet (including Mosaic) in her classroom described how she has used these tools, and a NASA LaRC researcher (who also works with teachers) presented how computers can be used in the field of Computational Fluid Dynamics (e.g., modeling the airflow over the wing of an airplane).

The didactic portion of most lessons was prepared and delivered using ClarisWorks or PowerPoint to give teachers an example of those capabilities; throughout the course, the instructional material presented was itself designed to be an example of the capabilities of educational technology. A presentation typically consisted of a lecture/demonstration with embedded practice for the participants. Visual material was presented via computer generated images on a large screen television.

Two Sample Lessons

There were two lessons that met specific goals: the ClarisWorks lesson (discussed in the sample lesson below) was important for achieving the goal of giving teachers the information required to complete assignments (goal 10), and the text-based Internet session better equipped the teachers to achieve the goal of continuing to learn the skills and information taught at TEI after the two week session was completed (goal 4).

The Internet Session

All teachers were given temporary NASA LaRC Internet accounts for the duration of TEI. Teachers were introduced to archie, telnet, gopher, ftp, and e-mail. A NASA reference manual entitled *Using the Internet: A Teachers Guide* (Amlin & Szady, 1993) was provided to the teachers. This text included general Internet information and procedures, specific pedagogical information concerning the Internet and how it is useful to teachers, and a lengthy section containing information about specific telnet, gopher, and ftp sites that the teachers can use in the classroom and as part of classroom preparation. These educational ftp, telnet, and gopher sites were used when practicing the skills necessary to use these various tools.

So that teachers might continue learning after the two week TEI session was complete, this lesson also included applying for Virginia PEN (Virginia's Public Education Network) accounts, a free text-based access to the Internet for educators. Only a PC and a modem with no special software are necessary to use VA's PEN, and every teacher had access to this. A VA PEN account allowed each teacher, after leaving TEI, to send and receive e-mail, to read the newsgroups available on Virginia's PEN, and to access ftp, telnet, and gopher. Because this was a content-rich lesson, time was spent in practice sessions discussing these concepts in more detail. In addition, a special integration session reviewed what each of these tools did and how they were different. Even so, in retrospect, this was still too much for one lesson. Either another lesson should have been devoted to text-based Internet tools, or the lesson should have been modified, perhaps concentrating on telnet and e-mail.

An Introduction to ClarisWorks

ClarisWorks was chosen because it is widely available in public school settings and provides integration of various computer capabilities. The wide variety of computer experience necessitated a short overview of the Macintosh and use of the mouse and keyboard. This was done by generalizing some notions that even experienced users might not be familiar with even if they had been using these concepts (e.g., "mark a block, then perform an operation on the marked block"). This technique allowed inexperienced users practice in using the mouse and keyboard, but allowed experienced users insight into general concepts used in most graphical-based interfaces (not just word processors; a drawing package was used as an example). Although it may seem that few lessons allow this dichotomy of shallow/deep teaching, it turned out to be used in many different lessons during the two weeks.

Cooperative learning partners sharing computers was helpful for each of the partners learning computer skills; inexperienced computer users were partnered with those more experienced, thus allowing inexperienced users to learn from their partners and allowing experienced users to view problems that their students, as new users, might have. Sharing of computers, however, was not always that beneficial. Although the synergistic effects of collaborative learning were always present, the individual learning goals of the teachers were restricted when computers were shared. To take advantage of both collaborative learning and the individual needs of the teachers, lessons were given with teachers sharing computers, but split afternoon sessions allowed teachers to have individual practice time on the computers. This policy, the split afternoon sessions, was not planned into the program initially; the schedule was modified at the teachers' requests (and was planned into the second session). Although the schedule was quite full, the TEI faculty were flexible, and modified the schedule when the teachers wanted more depth of coverage of a particular topic.

Because the assigned work for the course required a word processor, the emphasis of the ClarisWorks lesson was placed on learning the word processor. Knowledge of other capabilities of ClarisWorks was also viewed as important, so once some facility in word processing was established, incorporating documents of another type into a word processor was explored in order to demonstrate particular points.

Formal Evaluation

To determine whether TEI had changed how the teachers assessed their ability to use technology in the classroom and their ability to create lessons using technology, a one group pre-test/post-test design (Campbell & Stanley, 1963) was used. Teachers were asked to rate their access to, use of, training with, and ability to integrate 15 various technologies. Participants were able to mark their choices directly on survey forms. Then, data were entered into the database directly from the survey forms. Records were screened for input accuracy using double-entry and comparison methodology. Statistical analysis was accomplished using SPSS version 4.1.

This following research questions were addressed:

1. To what technologies do teachers have access?
2. What technologies do teachers actually use in the classroom?
3. Do teachers use the technology to which they have access?
4. What technologies are teachers trained to use?
5. What technologies can teachers integrate into their classroom lessons?

A difference in the pre-test/post-test scores for the last two questions would indicate that TEI had improved the confidence of the teachers to use technology. To address these two issues, the same questions were asked before and after TEI. Pre- and post-TEI comparisons of questions 4 and 5 using a paired T-test resulted in a statistically significant ($p<0.05$) gain in the participants self-assessed ability to use technology and in a significant ($p<0.05$) gain in the participants self-assessed ability to create effective lessons using technology.

Informal Evaluation

The educational portion of TEI was in general, extremely successful, and two follow-up sessions have been full of anecdotal evidence that the teachers learned a great deal and are using the information presented at TEI. This section discusses some of the factors that were keys to that success and some parts of the program where improvement is possible.

Lessons Learned

Internet Access. E-mail communication among the teachers was intended to be an outcome of TEI, and it appears that this communication has been much less than the designers would have liked. There could be several reasons for this, including lack of access (even though teachers have access to a computer with a modem, it may be not be convenient), but one change that future TEIs might incorporate is access to the Internet through means other than Virginia's PEN. VA's PEN turned out to be continually changing; the application process itself was confusing; the specific application screens were not user friendly; and it was not possible for the TEI faculty to get accounts for use in developing 'how-to' lessons. SEVAnet (Southeastern Virginia's network), a newly established freenet, is one possibility for giving teachers Internet access that could continue beyond the TEI session.

One Teacher/One Computer. It would have been better to have a computer for each teacher, and TEI 1995 is being planned with that in mind. Teachers worked better together and learned more from the instructor and from each other when they each had their own computer. Follow-up observations of computer laboratory assignments by the authors have reconfirmed the criticality of equipment availability.

More Practice Time. Teachers wanted more practice time during the session. Since the other portion of TEI was valuable to the teachers, there was no portion that could be eliminated to increase the practice time; it would have to be done after the scheduled sessions. Some teachers did come in early and stay late, but NASA LaRC security restricted the time that teachers could be on Center, so this provided a minimal extension, and there were only ten computers. Future TEIs should provide alternate practice sites for after hours practice time.

Factors for Success

Flexibility, choice of lessons, personnel, outstanding resources, and overall emphasis on education technology were some of the factors that contributed to the success of the ET portion of TEI.

The choice of lessons and the hands-on way in which they were taught contributed greatly to the success. The information was useful to the teachers; even though part of the lessons described state-of-the-art technology to which some of the teachers did not have access, except for one isolated instance, teachers never complained that they would not be able to use the information that we were providing. NASA LaRC provided state-of-the-art hardware and software that enabled the instructors to provide the hands-on lessons using the latest technology and most recent information. The fact that assignments were required to be completed using a word processor and that the Internet was one of the available resources that teachers used in preparing their final project helped teachers see the utility of the subject material.

Personnel contributed immensely to the success of the educational technology portion. TEI faculty were sincerely interested in helping teachers learn and they were available for consultation at all times during the day and for about an hour before and after the scheduled activities. The ET instructors (consisting of TEI, CNU, and NASA LaRC personnel) were flexible, open, and accessible. Each speaker gave his or her e-mail address and encouraged follow-up questions. The friendly atmosphere greatly enhanced TEI's learning environment. TEI also benefited greatly from having access to such a wide variety of expertise; the presence of such expert speakers validated both the importance of the teachers and the information being presented.

The TEI schedule was packed, but the TEI faculty and NASA LaRC designers felt that educational technology was a critical part of TEI; as a result, a substantial portion of TEI was devoted to ET. This allowed the ET portion of TEI to cover a great deal of material. In addition to the initial time scheduled for ET, TEI faculty were sensitive to the teacher's needs and desires; each two-week session was modified as teachers requested more or less instruction on a particular topic. For example, as mentioned earlier, split sessions were implemented at the teachers' requests. This flexibility contributed to TEI's success not only because the teachers were able to benefit from the changes that were implemented, but also because the teachers felt that they had a role in the execution of their workshop.

Conclusion

Teachers who participated in TEI felt more comfortable with educational technology as a result of the two-pronged vision/immediate use emphasis, and several have already become advocates for technology in their school system. Hands-on classes, high instructor-participant ratios and use of NASA LaRC's hardware and software resources all contributed to the success of the educational technology portion of the Teacher Enhancement Institute. NASA considered the TEI experiment successful and plans are underway for TEI 1995.

Acknowledgments

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Project Infusion: Teachers, Training, and Technology

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In August 1992, Dade County, Florida, was dramatically altered by Hurricane Andrew. Ten schools were completely destroyed, 80 schools were damaged, and thousands of dollars of equipment and teaching materials were lost. The rebuilding of schools and replacement of equipment and materials afforded the school district a unique opportunity to refurbish its schools with state-of-the-art technology. This technology, however, involved the sudden need to learn new hardware platforms, new software, and the use of networks. Before the full benefit of this unexpected infusion of technology could be realized, teachers had to be trained to use it effectively.

Project Infusion, funded by the U.S. Office of Education's Fund for Innovation in Education, sought to address the teacher training needs created by these changes and proposed a training model that had the capability not only of meeting the needs of hurricane-impacted schools, but also of directly influencing the training of personnel in instructional technology at the elementary school level across the entire school district.

Submission of the grant application was made by the Educational Computing and Technology department of the Adrian Dominican School of Education at Barry University, in collaboration with Dade County Public Schools (DCPS) in Miami, Florida. Dade County is the fourth largest school district in the nation and has 189 public elementary schools with 162,670 students in grades PK-6. In addition, there are 109 non-public elementary schools with approximately 12,000 students in grades K-6.

The purpose of this project is to develop, implement, and evaluate a model for providing district-wide teacher training in the use and integration of instructional technology to achieve curricular goals that are competency-based and designed to be world class standards.

The project objectives are:

1 To develop an effective teacher training model for integrating instructional technology within the district's newly developed Competency-based Curriculum
2. To implement the model district-wide
3. To assess the model's effectiveness in assisting teachers with the integration of technology in the classroom and in students' achieving new competencies
4. To disseminate information regarding the model and the results of the project.

Barry University proposed a training of trainers model to conduct system-wide training to help teachers utilize and integrate available state-of-the-art technology in the teaching of math, science, social studies, language arts and English as a second language.

The key components of this model include:

1. Best practice in teacher training/professional development
2. Levels of training: university, school based, and parent
3. Competitive recruitment of teachers to be trained
4. Intensive, graduate level training of project teachers
5. Administrative involvement at all levels of project
6. Clinical follow-up of trained teachers responsible for training personnel at their school sites

Best Practice in Teacher Training

The first three months of the first project year were set aside for planning, recruiting both students and two project staff members, and developing curriculum for the two graduate courses offered to project teachers. During this period, the project director conducted an extensive review of the literature on effective teacher training and effective teacher training in technology. The seminal works by Joyce (1990) and Joyce and Showers (1983, 1988) on effective inservice education and Joyce, Showers, and Rolheiser-Bennett (1987) served to guide the development of the Project Infusion training model.

Joyce and Showers' model (1983, 1988) was originally developed as a result of a meta-analysis of research studies on effective inservice training for teachers. Joyce and Showers' analysis identified a number of teacher training components that contribute to the transfer of knowledge or skills into actual classroom practice:

1. Presentation of theory or description of skill or strategy
2. Modeling or demonstration of skills or models of teaching
3. Practice in simulated and classroom settings
4. Structured and open-ended feedback (provision of information about performance)
5. Coaching for application (hands on, in-class assistance with the transfer of skills and strategies in the classroom).

Joyce and Showers conclude that for maximum effectiveness of most training activities, it would be wise to include several or all the components listed.

The design of Project Infusion and each of the nine training sessions developed by project staff focus on modeling desired technology integration strategies and providing frequent, consistent practice of skills in the context of classroom based scenarios. Learning theory and cognition are also emphasized as part of the reflection on the class activities and the rationale for the process used. Finally, coaching is implemented throughout the two courses offered to project participants.

Levels of Training

Each project year, elementary school teachers are selected from applications from Dade County Public Schools and interested private schools. We believe that by focusing on elementary school teachers, we can maximize impact and provide more generic integrative strategies in the training. Because elementary teachers typically are responsible for all the subject areas, they can more easily integrate technology across the curriculum in a holistic way.

Using grant monies, selected teachers receive tuition remission at Barry University for six credit hours in Educational Computing and Technology which they can apply toward 1) a master's or specialist's degree in Educational Computing and Technology and/or 2) state re-certification requirements. These teachers are called the Level I students or teachers.

Barry offered four 9-week cycles the first year of the project, and will offer five 9-week cycles during the second and third years. In this way, four groups of Level I students with 20 students per group were trained in the first year, and 5 groups of 20 students per group can be trained in the second and third years.

The first course the teachers take is ECT 680, Integrating Technology in the Elementary Classroom, a three-credit course that includes a comprehensive examination of instructional technology, learning theory and research in the field, competency-based curriculum and technology, models of teaching and learning with technology, and integration of instructional technology across the elementary curriculum. The second three-credit course, ECT 690, Teachers, Training, and Technology, is designed to be a practicum during which Level I project teachers are to: 1) develop, with their principals and/or school management teams, teacher inservices at their school sites; 2) carry out teacher training at their schools in collaboration with Barry University staff; 3) implement their personal technology infusion plan and evaluate its effectiveness; and 4) collaborate with teachers at their school sites to develop classroom infusion plans and parent training activities.

The teachers to be trained at the individual schools (called Level II teachers) receive Teacher Education Center (ETC) credit to apply toward re-certification. The Level II teachers, in collaboration with the Level I trainers, are responsible for developing and implementing a personal technology infusion plan for their own classroom teaching and for providing technology training to interested parents as part of their course requirements.

Level I trainers are supervised and mentored by project staff during the practicum course in a type of "clinical" follow-up as they conduct inservice training at their respective schools for their colleagues. The follow-up training is conducted collaboratively with project personnel present to provide feedback and encouragement to the trainers and to ensure that the quality of the training provided to Level II teachers is high. In some cases, inservices are videotaped for review and analysis by Barry faculty and Level I teachers.

Competitive Recruitment of Teachers

Eighty teachers from the school district and private schools were selected to participate in the first year of the project, with 100 teachers participating during each of the second and third years of the project. Another element of the teacher trainer selection process which we believe has enhanced its success is the selection of two teachers per school. In this way, support during the initial training and the follow up training can be generated and sustained.

The intensive training which Level I teachers receive makes it necessary for prospective participants to have an intermediate level of knowledge and sophistication in the use of instructional technology in order for the program to be successful. Prospective participants are required to provide documentation of the following:

1. Satisfactory completion of an introduction to computers or computer literacy course or commensurate experience
2. Proof of current activities using technology (student products, project descriptions, or narratives)

Intensive, Graduate Level Training

Level I training is conducted at Barry using Macintosh, DOS, and Windows platforms. The training content for the first three-hour course was designed as nine topical modules. All of the modules emphasize ways in which state-of-the-art technology can be used to strengthen instruction in the core subject areas:

Session 1	Intro to Technology across the Curriculum
Session 2	Teacher Tools
Session 3	Desktop Publishing for Teachers and Children
Session 4	Databases across the Curriculum
Session 5	Multimedia
Session 6	Authoring and Presentation Packages
Session 7	Telecommunications
Session 8	Putting It All Together
Session 9	Visioning; Best Practice in Teacher Training

Telecommunications is actually a strand that crosses each session.

Instruction for each of the sessions is provided by the project director, who is a faculty member from the Educational Computing and Technology department at Barry University, and the teacher on special assignment from Dade County Public Schools.

Administer/School Management Team Involvement

A key component of the Infusion model is active involvement of the school administrator and/or the school management team (for school-based managed schools) in all phases of the project. Project applicants must be recommended by the school principal. This recommendation is based not only on the teacher's level of expertise in technology and potential for graduate work, but also on the applicant's ability to train others. At the same time, the principal must sign a document stating that he or she is committed to collaborating with the teacher trainers in designing an inservice action plan and implementing Level II training at the school site.

Principals are also asked to attend at least one training session provided by the Level I trainer and to provide feedback to Barry personnel regarding the quality of training.

Clinical Follow-up of Trained Teachers

The second three-hour course, a 45 hour practicum, consists of:

1. Co-development of an action plan for inservice at the school site with the principal/school management team
2. Implementation of the inservice plan at the school site under the supervision of Barry faculty and the school administration
3. Evaluation of the implementation at the school site
4. Collaboration with Level II teachers in the development of their infusion plans and parent training activities
5. Development and implementation of a personal infusion plan designed to integrate technology into the competency-based curriculum for delivery in their own classrooms

Plus, preparation of one of the following:

1. An article about the project and its effects for publication
2. Presentation of project model or results to interested persons at local, regional, state, or national conferences
3. Development of a multimedia presentation on the project

The content of the Level II training conducted at the school sites is determined collaboratively by the Level I teachers and the school administration/management team after a careful review by the project director. Most teachers opt to receive inservice points for their participation in the training activities, ranging from 10-60 points toward re-certification.

As part of their inservice requirements, the Level II teachers are asked to 1) design, implement, and evaluate a personal infusion plan for integrating technology in their classrooms, and 2) to design some type of parent training. The latter requirement frequently takes the shape of a technology night" or a Saturday class where parents and children interact together with a specific piece of software, or a hands-on training session for parents, or a number of creative ways teachers can devise to deliver training.

The Level I teachers supervise the Level II teachers' implementation of their action plans and often serve as mentors to novice and intermediate users at their schools.

Evaluation Plan

The evaluation model used by Project Infusion includes formative and summative evaluation processes, with the goal of measuring progress towards project objectives and ensuring the smooth operation of the program.

Formative Evaluative Procedures

Progress toward the project objectives is established for Level I teachers in the following ways and kept in individual folios:

1. Course grades for each of the two courses taken
2. Course evaluations completed by project teachers on the effectiveness of their training at Barry
3. Pre/post checklist designed to assess level of use of technology in the classroom before training and 6 to 12 months later
4. Evaluation form designed to measure the effectiveness of the inservice training provided by Level I teachers
5. Examination of the action plan developed by each school partnership for their school sites for feasibility
6. Administrator rating of the effectiveness of the training provided at the school site
7. Evidence of publications, presentations, or product development that indicates extended activities in the use of technology in the classroom
8. Evidence of additional course work or professional development activities related to the use of technology as a classroom tool

For Level II teachers, similar measures will be obtained and kept in folios:

1. Satisfactory completion of the TEC component(s) at their school sites

2. Course evaluations completed by teachers on the effectiveness of their training by Level I trainers and Barry staff
3. Pre/post checklist designed to assess level of use of technology in the classroom before training and 6 to 12 months later
4. Development and implementation of a technology infusion plan for their own classrooms
5. Examination of the action plans developed by teachers for training parents and the results of training
6. Report on the challenges of using technology with students and how those challenges can be addressed

Summative Evaluation

At the end of each project year, the project administrator is responsible for completing a report of progress toward project goals and objectives. A comprehensive summative evaluation report will be submitted at the end of the third project year.

At a minimum, the final evaluation report will include:

1. Number of Level I and Level II teachers trained
2. Number of public and private schools involved in training
3. Course evaluations of Level I and Level II teachers
4. Descriptions of training content
5. Descriptions of formative evaluation data which influenced policy or practice
6. Descriptive/evaluative summaries of Level I and II student folio
7. Data analysis from the pre\post checklist on integration of technology in classroom activities
8. Evaluative data derived from the videotaped training sessions
9. Evidence of publications, presentations, and products developed as a result of the project
10. Evidence of numbers of students seeking additional coursework or professional activities related to technology as a classroom tool

In addition to the above mentioned processes, monthly budget reviews are conducted by the project director and the Controller's office at Barry.

Dissemination Plans

We believe that this project demonstrates an effective model for district-wide training of teachers in the use of technology across the curriculum to support world class curriculum standards. We hope to share the model, its implementation, and results with other educators and government agencies across the United States.

Project information will be shared with the Bureau of Educational Technology of the Florida Department of Education, which has a broad dissemination function to both public and private schools, district offices, universities, and government agencies. This Bureau is responsible for the statewide telecommunications network called FIRN, which will also be used tohare results.

Each Level I student will be responsible for one of the following dissemination tasks:

1. Submitting an article about the project and its effects to a newsletter, newspaper, journal, or electronic network
2. Presenting the project model, implementation, and/or results at PTA meetings, local, regional, state or national conferences, or other interested parties
3. Developing or co-developing with Barry faculty a multimedia presentation for disseminating information about the project
4. Assisting in the development of the application for review by the Joint Dissemination Review Panel.

This dissemination model makes for information sharing on a broad scale and places Level I teachers in an active role of informing other teachers about technology and its uses in education.

Barry faculty, in collaboration with interested students, will develop a multimedia presentation describing the project and its accomplishments, along with video clips of actual Level I and Level II training for dissemination to interested universities or school districts.

Finally, if the project's model and implementation prove effective, the university will make application to the Federal government's Joint Dissemination Review Panel for review as an exemplary program.

Conclusions

Using the training of trainers model, 93% of the 189 public elementary schools in Dade County could be inserviced during a three-year period, with two people at each school having had graduate coursework in the integration of instructional technology across the curriculum.

Assuming that these Level I teachers train an average of 30 teachers at their respective school sites, in three years approximately 5,200 teachers will be directly impacted by this training project. These teachers directly or indirectly impact approximately 125,000 students. We believe that this model has already proven to be a highly cost effective method of providing high quality teacher training in state-of-the-art instructional technology and that the benefits of this infusion of technology training will continue for many years to come.

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Designing Technology Staff Development: A Phased Approach

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In 1993, the University of Houston began developing a consortium of four area universities, eight Professional Development and Technology Schools, and local educational service agencies. The primary goal of the consortium was to prepare teachers for urban, multicultural classrooms. Funded by a grant from the Texas Education Agency, the multi-year project known as The Houston Consortium of Urban Professional Development and Technology Schools, seeks to attenuate several persistent problems in teacher education by training teachers who are both sensitive to the needs of an urban, low socio-economic status, and culturally diverse population, and who are capable of integrating technology into their instruction (Robin, et al., 1994).

Now in its second year, the Consortium continues to work toward developing a model for a site-based, multicultural sensitive, technology-rich teacher education program. Participants in the project include faculty members, teachers, staff, and students from four Houston area Colleges of Education, 16 professional development schools, and several local educational service agencies. As part of the Consortium's mission, several hundred Houston area university faculty, K-12 teachers, preservice teachers, and various staff members are receiving thousands of dollars of computer hardware, software, and telecomputing access through the grant project.

The challenge facing the Consortium is one that is also being faced at school districts and university campuses around the country: how to develop a community of learners comfortable with the use of technology and motivated to seek innovative ways to integrate it into the curriculum. During the first year of the project, the emphasis was on distributing equipment, developing a telecomputing infrastructure, and defining the technology-related training needs of Consortium members. In the article, *Developing an Electronic Infrastructure to Support Site-Based Teacher Education,* (Miller & Robin, in press), a description may be found of the telecomputing resources that have been developed for Consortium members. Many obstacles were identified during the start-up year of the project as participants began to use the hardware and software provided by the grant. Now in its second year of operation, the Consortium is seeking to overcome these obstacles by focusing our training efforts on basics of computer literacy and multimedia and the use of the telecomputing resources that have been developed

Creating a Technology Training Program

One major goal of the Consortium is to offer a wide range of training modules and methods of delivery to insure overall competency in foundation-level technology skills while meeting the diverse needs of the many different programs represented.

To try to meet this goal, we developed a program that uses several phases of training. The first phase can be brief but mandatory and is essential to achieving a basic level of skills mastery with the Macintosh computer and operating system across the Consortium professional staff. The second phase develops the component competencies needed in the areas of word processing, data management, graphics, multimedia and telecommunications. The third phase consists of a large of number of diverse offerings designed to meet the varying needs of our schools and programs. The three phases of training we developed, are:

- Phase I Training - Foundation Computer Use Skills with the Macintosh
- Phase II Training - Component Skills in ClarisWorks and Telecommunications
- Phase III Training - Applications of Technology for the Teacher and Integration in the Classroom

Phase I Training

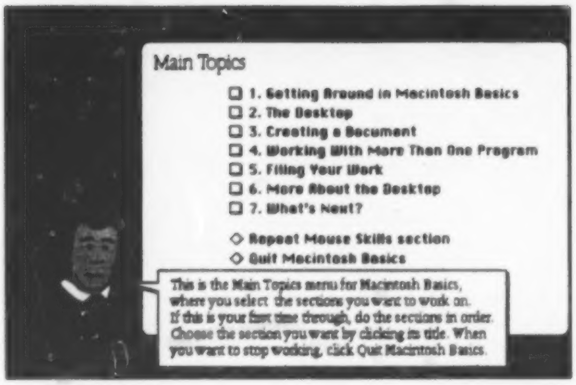
The objective of Phase I Training is to develop foundation skills involved in manipulating icons, windows, files, folders, menus and other elements of the Macintosh's graphical user-interface. Consortium members need to demonstrate competency with all elements of the "desktop" metaphor.

The basic training consists of a computer-based tutorial and a manually administered assessment. All Consortium members involved in staff development must successfully complete the activities of this module before participating in any subsequent phases of training. Some participants may prepare themselves for the assessment by enrolling in workshops offered by the regional Educational Service Agency, their districts, or other institutions. Other participants may need no further preparation for the assessment because of their prior experience.

Training on the delivery and assessment of Phase I is given to Site-Based Teacher Educators (SBTEs), members of the Consortium who have been selected to participate in the training needs of their school and possibly a nearby school in the same district. A limited number of key personnel at each site have also been selected to work with the SBTEs and they too are given training. These individuals will then be responsible for making Phase I training available to the professional staff at their site and keeping track of those who have successfully completed the training.

The Phase I lesson is designed to provide foundation skills and concepts for new users of Macintosh personal computers. It is based on the computerized tutorial, "Macintosh Basics," which is provided as part of the standard software with all Macintoshes. The presentation, practice and mastery of the material is accomplished by working through the sections of the tutorial individually (See Figure 1). Trainers are available to assist in locating the computer containing the tutorial and starting the tutorial software.

The drills and activities at the ends of the sections of the tutorial allow Consortium members to practice each skill until they feel comfortable with it. When they have completed the tutorial, a trainer gives a quick assessment to gauge the mastery of the lesson. Although some Consortium participants have sufficient previous experience with computers to pass the test, those with no prior Macintosh computer experience are able to perform well on the test material by simply working through each section of the computer-based tutorial.


Main Topics
☐ 1. Getting Around in Macintosh Basics
☐ 2. The Desktop
☐ 3. Creating a Document
☐ 4. Working With More Than One Program
☐ 5. Filing Your Work
☐ 6. More About the Desktop
☐ 7. What's Next?
◇ Repeat Mouse Skills section
◇ Quit Macintosh Basics

This is the Main Topics menu for Macintosh Basics, where you select the sections you want to work on. If this is your first time through, do the sections in order. Choose the section you want by clicking its title. When you want to stop working, click Quit Macintosh Basics.

Figure 1. The Main Menu of the Tutorial

Assessment of Skills and Concepts

The assessment portion of Phase I tests mastery of the following skills which correspond to (major sections of tutorial including the section on mouse skills) items 2-6 of the main menu and the item entitled "Mouse Skills section." Members are not tested on the terminology directly, but are asked to perform some operations on the computer that require knowledge of the terminology.

The skills being assessed include:

Mouse Skills - Perform point, point and click, select and drag operations.

The Desktop - Identify and manipulate the trash, floppy and hard disk icons and the pull-down menus.

Creating a Document - Launch the ClarisWorks word processor, enter text, save to current folder. Concepts: documents and applications.

Working with More Than One Program - Launch the word processor and paint program, cut a graphic from paint program to word processor, save file, use the multifinder menu.

Filing Your Work - Create and name folders, manipulate files, open and close folders, use balloon help.

More About the Desktop - Double-click open, use window features, putting items in the trash, emptying the trash.

The rationale of this approach is that even Consortium members who are complete computer novices can sit down at the computer and use the tutorial to become comfortable with the basics of clicking and dragging, manipulation of the mouse, and the look and feel of the Macintosh operating system. Before being tested, users are given as much time to prepare as they need and trainers are able to provide assistance and answer any questions. In our experience, everyone who has taken the assessment has been successful.

Phase II Training

Once users become comfortable with the computer's user interface, the focus of Phase II Training shifts to the development of proficiency in the component skills of an integrated productivity application (in our project we use

ClarisWorks), telecommunications and an introduction to multimedia. This includes all of the basic skills needed to make use of the following tools: word processing, spreadsheets, electronic mail, database, drawing, painting, graphing and presentation making. The emphasis on multimedia in Phase II training is limited to its uses and applications within ClarisWorks.

The components of Phase II training include:

- Basic word processing skills
- Basic computer drawing
- Basic uses of paint tools
- Basic spreadsheet skills
- Introduction to graphing and charting
- Introduction to computer presentations using ClarisWorks
- Basic use of color scanners and hand held scanners
- Basic audio and video capture
- Introduction to the use of interactive multimedia software
- Introduction to CD-ROM technology
- Introduction to laserdiscs and interactive laserdiscs
- Introduction to hardware and software for telecommunications
- Basics of Internet connectivity: SLIP, PPP, and Direct Internet Connections
- Basic Electronic Mail features
- Introduction to Lists and Newsgroups
- Basic Gopher features
- Basic introduction to research tools using Gopher and Veronica
- Introduction to multimedia resources on the Internet

Phase II training is currently underway

Phase III Training

Phase III training is still being developed. When completed, Phase III training is intended to offer a diverse menu of applications to meet the individual needs of the four different Universities' programs as well as the needs of the individual K-12 schools participating in the project. These modules will focus on the use of multimedia and telecommunications technology within the K-12 curriculum. Phase III differs from the earlier phases in assuming that the participants have a thorough grasp of the fundamental skills involved in the use of ClarisWorks, multimedia, and telecommunication applications and are seeking ways that these resources can be integrated into the curriculum. Phase III training will include:

- An Introduction to Authoring in HyperStudio
- An Introduction to Authoring in HyperCard
- 20-30 modules that extend the curriculum with ClarisWorks
- 10-15 modules that manage classroom tasks with ClarisWorks

Telecomputing Training

A second goal of the Consortium is to provide training that allows participants to fully utilize the telecomputing resources we developed during the first year of the project. The Consortium has already made a substantial investment in improving computer-mediated communication among its members during year one of the project. A communications server was established in the University of Houston College of Education and e-mail accounts were created for all those who did not already have them. Furthermore, SLIP connectivity was provided to permit members to take advantage of easy-to-use, Graphical User-Interface (GUI) communication tools such as the e-mail program, Eudora, NewsWatcher for reading news and online discussions, TurboGopher, and Netscape World Wide Web browsing software. An Internet-accessible gopher site was established so that important documents and software can be retrieved by all interested members and training has been and continues to be offered to all university faculty members and to teachers and interns working with the Consortium.

During the school year, various telecomputing training sessions are offered for Consortium members at both university and K-12 sites several times a month. These sessions normally are held in the afternoons when teachers are finished with classes and are designed for small groups so that hands-on activities are included. The following training sessions are currently being offered :

- SLIP QuickStart
- Getting Started with Eudora
- An Introduction to Gopher

In addition, during the first year of the project, an intensive summer telecomputing workshops was held for a larger group of Consortium members. This week-long session allowed members to concentrate on a wide assortment of networking issues including SLIP connectivity, GUI Internet tools, searching the Internet for educational materials, and integrating Internet resources into the curriculum. Following the first workshop, a number of recommendations were discussed which will be incorporated into future workshops. These include:

- Send out a pre-workshop survey to measure participants' needs and skill levels
- Send out pre-workshop explanatory materials to aquatint participants with nature of workshop activities and expectations
- Provide more hands-on time
- Include more content-specific activities in math, language arts, science, etc.
- Develop additional training materials in print and electronic format
- Offer post-conference follow-up sessions for enthusiastic participants

Advanced Telecomputing Tools

During the first year of the Consortium, we concentrated on providing SLIP connectivity and access to GUI Internet tools. But as year two began, we realized that more needed to be done to streamline communications between members, whether that communication is in the form of e-mail, telephone, fax or postal mail. We are now developing a series of telecomputing tools which will help meet the needs of Consortium members and help define the role that telecomputing can play in an educational environment. The Houston metropolitan area is very spread out and many project participants must travel large distances to attend Consortium meetings. In an attempt to minimize the number of face-to-face meetings members need to attend, we are developing electronic tools that can be used asynchronously. Our goal is to develop an online method of communication which is easy to use and requires minimal training. With this in mind, we are creating an automated process to facilitate communication among the Consortium's hundreds of members. These tools allow members to:

- Look up the name of anyone working with the Consortium and view directly their phone number, fax number, title or postal mail address. Imagine being able to address an e-mail message to them with a single button click.
- Obtain a list of the members of the steering committee or the SBTEs and being able to send a message to any or all of them without having to collect their individual address information.
- Obtain electronic copies of all schedules, notices, forms, and other paperwork involved in the project and being able to print them locally rather than relying on postal mail or hand delivery.
- Communicate with anyone in the Consortium in the same, easy method regardless of whether the recipient has a Consortium or TENET e-mail account, uses SLIP or not, and works at home, at school or in the office.

The centerpiece of this initiative is an electronic membership directory of all Consortium participants and a collection of mail distribution lists. These items, together with the communication server that has already been established, makes it possible to communicate easily with both groups and individuals in the Consortium.

E-mail distribution lists make it possible to direct an announcement to groups such as the steering committee or the general staff. The advantage to automated mailing lists is that the maintenance of the list is centralized so that the sender needs to know only the name of the list, for example, the list, "PDTS-TECH@pdts.uh.edu" can be used to reach the technical specialists working with the Consortium. An advantage of this approach is that the membership of the list can change at any time but it need be known only to the Consortium server, not by the sender.

The following lists have been created initially and other lists can easily be added in the future:

PDTS-ALL	Staff, Interns, Mentors, and others
PDTS-STAFF	Staff members of the Consortium
PDTS-SBTE	Site-based teacher educators
PDTS-TECH	Technical specialists
PDTS-STEERING	Steering Committee
PDTS-POLICY	Policy Council

Lists can be established in such a manner that only a designated individual may send mail to the list, so that all "postings" to the list must be reviewed and approved in advance; this arrangement is good for lists whose main purpose is to distribute announcements, schedules of events, official documents, etc. Lists can also be set up so that all members of the list may send mail to it, which is useful for promoting public discussion within a group.

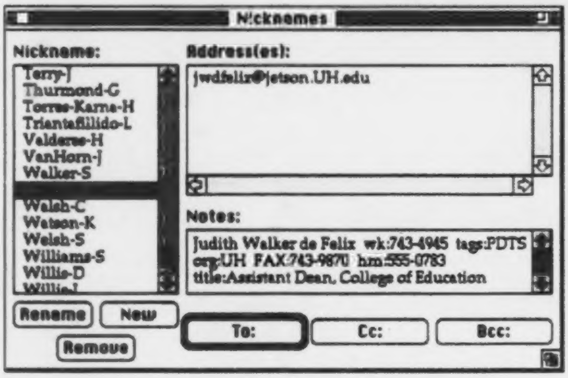
Membership in the lists can be controlled or opened to "subscription." Subscription permits individuals to join (or remove themselves from) a list by sending a simple e-mail message. We control the membership of the sub-groups, such as the policy council, while opening PDTS-ALL to subscription. This permits those working with the Consortium in any capacity to join the general mailing list and to informed of upcoming events and activities.

Electronic Directories

In addition to the mail distribution lists, an electronic directory of all Consortium participants can be compiled. By providing this directory to all members we have streamlined the use of e-mail as well as other types communication (phone, FAX and postal mail). This database is available as a Eudora "nickname" file, a ClarisWorks database and, a printed directory.

New subscribers are requested through e-mail to fill out and return a registration form containing name, phone numbers, affiliation and other contact information. This information is collected and compiled by an "infobot" on the server, an automated process for information collection and tabulation. Once collected, the data may be retrieved by all members from the Consortium gopher site. Consortium members may update their information at any time by sending an updated registration message to the infobot.

With this information collected, members will be able to access an electronic directory such as the one shown below in Figure 2.



jwdfelix@jetson.UH.edu

Judith Walker de Felix wk:743-4945 tags:PDTS org:UH FAX:743-9870 hm:555-0783 title:Assistant Dean, College of Education

Figure 2. The Electronic Directory in Eudora

These tools, mailing lists and electronic directories are the next logical step in furthering the ease of communication among participants of the Consortium. The resources needed to set up and maintain these services are small in comparison to the benefit to the Consortium community at large. By providing this kind of ongoing service and development, we are helping accomplish the goal of using telecommunications to support a community of site-based educators.

Conclusion

Our initial experience in delivering technology training for the project has shown that a great variation in skill levels exists among in-service educators. This conclusion was reached as a result of the frustration felt by some participants during our initial attempts at providing training opportunities during the first year of the project. Initially, all participants stated a desire for training that focused on applications of computer technology in the classroom. What we found however, was that many participants lacked the foundation skills (how to use a mouse, for example), which prevented them from benefiting from such training. This frustration became acute when workshops were offered to provide curricular applications of technology without first preassessing the skill levels of workshop participants. In order for training to be effective for all members of the Consortium, a three staged training approach was developed that ranges from foundation skills, through component skills of the integrated productivity applications, to curricular integration. In this way, all members of the project can get training in the areas that match their particular computer literacy skill level.

Another observation at this point in the project is that despite the wide-spread belief that use of the Internet is free of charge, the real cost of using telecomputing lies in delivering staff development that reaches a large percentage of inservice teachers and has a lasting effect. We feel that we are now ready to take advantage of the telecomputing infrastructure we developed during the start of the project by providing both basic and advanced telecomputing training opportunities to all Consortium members.

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Electronic Technologies, Educational Change, and the Narrative: An Experiment in Graduate Education

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This study examined a systematic approach to integrating the narrative mode of thought into graduate study in the hope that teacher-students might risk questioning time honored practices and use expository knowledge and class experiences to imagine what technology using schools of the future might become.

In August 1994 I was preparing for the beginning of the academic year. A new group of 48 graduate students would soon be coming together as a cohort group to study integrating technology in schools (Norton, 1994). Phone conversations with some of the new members and my experiences with previous groups suggested their most pressing goals centered on learning to use the new technologies. Central to my goals for the group was to promote their serious consideration of the nature of the social, cultural, political, and epistemological impacts of these technologies. I hoped they would wrestle not only with how to use these technologies but also with their meaning for the practice of educating, teaching, learning, and schooling. I was aware, however, that each would be joining the group with a long, deep, robust picture of education, developed over years of watching others and teaching themselves. Such a picture would not be easily challenged. The old adage, "we teach as we were taught," has been confirmed repeatedly by my experiences. So, I asked myself, what experiences might be effective in encouraging these ITS students to risk questioning time honored practices and envisioning alternative futures. In short, how might these teachers confront today's challenges without being restricted by past patterns of response?

Identifying the Alternative

The traditional approach for engaging students with thoughtful reflection that combines theory and research into potential action is to rely on expository discourse such as textbooks, research papers, lecture, and the like. Such examples of expository discourse lead students to search for universal truths that depend on formal or empirical verifiability. They encourage modes of thought that employ categorization or conceptualization as well as operations which establish how general propositions can be extracted from statements or events. They deal in causes and make use of procedures to assure verifiable references and to test for empirical truth. As Bruner (1986, p. 13) states, the expository mode is

> . . . defined not only by observables to which its basic statements relate, but also by the set of possible worlds that can be logically generated and tested against observables - that is, it is driven by principled hypotheses . . . . The imaginative application of the paradigmatic mode leads to good theory, tight analysis, logical proof, sound argument, and empirical discovery guided by reasoned hypothesis.

Educational practice, however, is not always logical, easily linked to causes, nor subject to tight analysis. The human condition is more complex than that. The art of teaching and learning is informed by the science of teaching and learning but must be rendered daily into a complex narrative. Narrative discourse, writes Bruner (1986, p. 14), convinces one of lifelikeness, presents models for the conduct of life, and addresses how we come to endow experience with meaning.

> It deals in human and humanlike intention and action and the vicissitudes and consequences that mark their course . . . . story must construct two landscapes simultaneously. One is the landscape of action, where the constituents are the arguments of action . . . . The other is the landscape of consciousness: what those involved in the action know, think, or feel, or do not know, think or feel . . . .

Much of disciplinary knowledge and practice, in fact, depends on the story. The economist Robert Heilbroner once remarked that

> when forecasts based on economic theory fail, he and his colleagues take to telling stories - about Japanese managers, about the Zurich "snake" . . . businessmen and bankers today (like men of affairs of all ages) guide their decisions by just such stories - even when a workable theory is available. These narratives, once acted out, "make" events and "make" history. They contribute to the reality of the participants (Bruner, 1986, p. 42).

Like economists, teachers use stories to inform practice. Everyone has heard teachers tell the story of a favorite unit, a clever or unusual student, or the perfect field trip. Even more important, students and teachers write their stories each day - not only in their notebooks but in the conduct of their lives. Is it possible that if teacher-students are challenged to invent new stories with a future twist they might be able to imagine more than a series of variations on their own daily stories?

Implementing the Alternative

Speculating that the integration of the narrative mode of thought might promote teacher-students' ability to see alternative images of educational practice, the narrative was woven throughout the syllabus and the ongoing academic work of the group. During the nine credit hour seminar which met weekly and one Saturday a month as well as in small group activities using telecommunications, students read eight books drawn from the nonfiction, trade market and learned to use databases, video/television, simulations, hypermedia, computer graphics, and telecommunications. Facilitating the development and use of the narrative mode of thought was threaded throughout these activities.

During the third week, students were introduced to the narrative mode. The narrative was contrasted with the expository; quotations like the Heilbroner quote above were presented. Class discussions identified the elements of a story grammar: setting, sequence/plot, character (main and supporting), theme, climax, problem, and resolution. Students were then asked to brainstorm phrases that they might use if they were to write a story about today's schools. Their responses were categorized and tallied for later use (Table 1).

During Week Four, the researcher/instructor read Ray Bradbury's *There Will Come Soft Rains*. Teacher-students were assisted in analyzing the story setting. Although the story is set on a futuristic Venus, the teacher is still portrayed as the director; students are still grouped by age; curriculum is still reading and writing oriented; learning is still bounded by classroom walls. Class discussions focused on how pervasive our image of education is and how difficult it is to break free of this model. A second story written by one of the instructors, Catie Angell, was then read. In this story again set in the future, the curriculum focuses on learning to tell illusion from reality; computer simulations are the primary instructional mode; time parameters are flexible. Teacher-students were challenged to write an educational story of the future as their final assignment of the semester.

By the end of the fourth week, the group had read and discussed two books and spent both class and outside of class time mastering telecommunications. Group members were challenged to design and complete a telecommunications project that involved the students in their classrooms. The "story" of their project was to be collaboratively written online by the end of the twelfth week.

During the seventh and eighth week, the central topic for readings and discussions centered on the role of television and video in contemporary culture. In addition to class discussions, group members compared and contrasted the ways in which print and video handled information, in this case narrative information. This facilitated the ongoing work of the group while also emphasizing the construction of narrative. One week, a video from the Ray Bradbury Theater, *The Electric Grandmother*, was compared with the printed version of the story, *I Sing the Body Electric*. Particular attention was paid to comparing the ways in which setting and character were portrayed. During the next week, a video of Star Trek: The Next Generation in which Mr. Data creates a daughter was compared with Isaac Asimov's, *The Bicentennial Man*. Particular attention was paid to how the different plots and sequences of events conveyed a similar theme.

During Weeks 9 through 14, group members were asked to examine their reading assignments for quotations which might suggest ideas about settings, characters, themes, and problems for stories about educational practice. For example, in their reading of Lewis Perelman's *School's Out*, group members identified and explored what a setting might be like if it resembled his "shopping mall". They discussed his notion of apprenticeship as it might influence the roles of teacher and student characters. Students uploaded their quotations to their telecommunications groups and participated in online "phone" discussions about these quotations led by peer experts working with the group.

The last two reading assignments for the group were sample stories. The first (Week 13) was Tracy Kidder's ethnography about a research and development group, *The Soul of a New Machine*. Group members discussed it as a possible metaphor for teaching and learning in the future. The second (Week 14) was Orson Scott Card's *Ender's*

Game, a science fiction story about the education of a young man so that he might save his world. Group members discussed the story for the ways in which technology was integrated into the education process experienced by Ender and for the ways in which the story challenges our notion of what needs to be learned, who decides what is to be learned, and to what end learning should be directed. Group members' own stories were due, discussed, and shared during the fifteenth week.

Analyzing the Alternative

This study asked four questions related to the potential of using the narrative mode of thinking as a graduate level instructional strategy for promoting teacher-student thinking about educational change.

Question One: Would the use of the narrative mode of thinking promote teacher-student abilities to imagine technology using schools of the future? Forty-seven stories were submitted. Of those, 66 % of the stories represented a serious attempt to explore the impact of technology on schools of the future. Of these, 21 % explored how teachers might adapt or change when confronted by technology. They asked what teachers' new roles and responsibilities might be and how teachers might learn to meet these new challenges. Twenty-nine percent of the stories were set in the near future and reflected explorations concerning how today's schools might be adjusted to reflect contemporary trends such as Gardner's multiple intelligences, learning centers, and technology in the classroom. The remaining 50 % of the stories explored the teaching/learning process of the more distant future with a focus on students' learning, examining what ought to be learned and how it might be learned.

Thirty-three percent of the total stories submitted dealt only tangentially with educational practice. Instead, these stories were explorations of the impact that technology might have on the social, cultural, and personal lives of people in the future. These stories explored themes related to the use of technology; how technology might complicate or resolve the environmental well-being of earth; how technology might impact interpersonal relations either romantic or inter cultural; and how technology might be used to either humanize or dehumanize.

From this analysis, it is clear that the narrative mode of thinking was not universally effective in promoting the development of a vision of future educational practice. It seems that for some teacher-students it was necessary to first wrestle with the implications of technology for their own social and personal concerns before they could move on to explore these implications for their professional lives. However, for two thirds of the group's members, the narrative mode seemed to provide an appropriate, liberating vehicle for imagining possible educational changes.

Question Two: Would the narrative mode of thinking enable teacher-students to move beyond variations on established patterns of teaching/learning? Using the categorized phrases related to today's schools collected during the third week, stories were analyzed for reflections of similar features. Table 1 presents a comparison of the percentage of times features appeared. An examination of the table reveals that very few of the features listed as descriptive of today's schools appeared in teacher-student stories. It is clear that the narrative mode was a viable approach for expressing new ideas and leaving behind conventional images.

Table 1
Percentage of Respondents Listing Each Item on List 1

Phrases That Describe Educational Settings	Today's Schools	Student Stories
Context described as a classroom	100%	29%
Desks (26% of these referred to desks in rows)	57%	0%
Computers present (most for Teacher use)	32%	93%
Bulletin Boards	30%	0%
Dirty, untidy, stained, run down	30%	0%
Piles of papers and Books	28%	18%
Cabinets and Tables	26%	0%
Student Work	26%	21%
Posters	19%	0%
Bookshelves with supplies and/or manipulatives	19%	25%
Chalkboards	17%	0%
Computer Labs somewhere in school	15%	0%
Teacher Desk	13%	0%
Clean, Tidy	11%	0%
TV/VCR	6%	4%
Teacher as Character - What Doing		
Lecturing or Talking	60%	7%
Testing, Grading, Doing Paperwork	30%	0%
Working with small groups or helping students	25%	43%
Preparing	21%	29%
Monitoring, Sitting, Walking around	21%	0%
Sitting at desk	21%	0%
Disciplining	17%	7%
Parenting Students/Counseling Students	15%	0%
Working with colleagues, attending meetings, and Committees	13%	0%
Having fun	13%	0%
Giving Directions	13%	29%
Teacher as Character - Responsibilities		
Grading, Evaluating, Being Accountable	42%	0%
Meeting Competencies/ District Curriculum	38%	0%
Maintaining Records and Paperwork	38%	0%
Managing and Controlling	36%	7%
Planning and Doing lesson Plans	32%	29%

Communicating with Parents	32%	21%
Duty	28%	0%
Discipline	21%	7%
Counseling/Motivating	21%	18%
Ensuring Safety	19%	11%
Going to Meetings or Serving on Committees	15%	0%
Teach	13%	0%
Meeting Time Commitments	11%	0%
Being Supportive and Positive	9%	52%
Decorating and Cleaning Room	9%	0%
Teacher as Character - Themes/Goals		
Helping Students to learn, to graduate, to become good citizens, etc.	49%	21%
Work effectively with administration, state departments, staff, colleagues, parents	40%	36%
Get through the day, through the year, to retirement	36%	0%
Cover Prescribed Curriculum Material	28%	0%
Insure Safety	21%	11%
Change and learn more	14%	64%
Do their best	14%	0%
Motivate Students	14%	32%
Work with Community	12%	57%
Provide food to needy students	9%	0%
Students as Characters - What Doing		
Writing	45%	11%
Reading	43%	14%
Talking (as part of school work)	38%	11%
Working Together	38%	93%
Working Alone	32%	4%
Listening	26%	1%
Sitting at Desks	26%	0%
Messing Around	26%	4%
Taking tests	19%	0%
Learning with Computers	19%	93%
Nothing, Daydreaming, Spacing Out	15%	0%
Playing, At Recess	13%	0%
Sleeping	13%	0%
Watching Videos/Movies	9%	2%
Students as Characters - Responsibilities		
Pay attention, Be quiet, listen	38%	0%
Follow rules, behave, not fight	36%	0%
Do their Work	36%	0%
Learn	36%	100%
Be prepared, Have Supplies	34%	0%
Be Punctual	32%	0%
Cooperate with others	30%	100%
Attend consistently and regularly	28%	0%
Be polite and respectful	26%	4%
Try their best	13%	0%
Be neat and clean	11%	0%
Ask questions	11%	100%

Question Three: What educational practices would teacher-students substitute for traditional patterns of teaching/learning? Although each teacher-student's story was as unique as the student, many common attributes characterized the stories. Over 75% of all the stories shared the following features: student work was completed collaboratively; curriculum for the portrayed schools of the future was transdisciplinary, problem-based, and directly connected to the ongoing work or dilemmas of the community; student work was framed as life long learning and developing solutions to robust problems over periods of time from one week to one year; knowledge of past human experience was portrayed as important for solving problems; and the importance of isolated factual knowledge was minimized and seen as significant only when it was connected to experience.

All the stories integrated technology into educational practice. Ninety percent of the stories saw technology as supportive; artificial intelligence systems were often featured as the primary "teacher" and were portrayed as guides or facilitators, sympathetic and supportive of learners. Telecommunications and simulations, particularly in the form of virtual realities, were the predominant technologies with hypermedia as the next most prevalent. Story settings generally cast the learning environment as flexible, often home-based, generally supplemented by times for social gathering. In fact, over half the stories systematically built in times for face-to-face learning.

Characters created predominantly as "teachers" were also portrayed as "learners" while characters created predominantly as "student" were also assigned "teaching" responsibilities. The most prominent responsibility ascribed to "teacher" characters was that of curriculum developer, either in the design and facilitation of concrete learning experiences or in the design of technological applications. The primary responsibility ascribed to students was as problem-solver. Learning was portrayed as deeply rooted in the family and the community. Forty-six percent of the stories included grandparents as important characters. Learning was geared toward maximizing the potentials of the individual while simultaneously supporting the growth and development of the community. One student captured the spirit of many of the stories when he wrote "there are two curriculums - a curriculum for all and a curriculum for each."

Question Four: What role would teacher-students' expository readings and class experiences play in their stories? The role of the teacher-students' class experiences and readings was evident in all their stories. There were numerous "inside" illusions to class projects. A large part of the first semester centered on mastering telecommunications and Internet resources while also using telecommunications capabilities to promote members' own learning. It was not particularly surprising then that telecommunications and the World Wide Web were featured prominently and frequently in teacher-student stories.

Evidence of the impact of students' expository readings was also easily observed. Many story characters shared names with the authors of the books read and discussed during the semester. For example, teacher-students read Neil Postman's *Technopoly*. One student described a character in their story called Postman as having been "included" as part of the problem-solving group to "inject a voice of doubt into the group." Five of the stories had a character named "West" - the name of the director of the research and development group described in Kidder's *The Soul of a New Machine*. One story described a group of students learning team work, trust, and problem-solving. The characters were named Kermit, Logon, Bootes, and Telnet, features of telecommunications learned during the semester.

When teacher-students were asked what role their class experiences and readings had in their ability to write their stories, there was unanimous agreement that their stories could not have been written if they had not been preceded by these activities. Teacher-students also believed that writing their story would not have been possible without the class experiences with narrative as a mode of thinking that had been woven throughout the semester. One student remarked that as she neared the end of her story she realized she had described the setting and characters but that she had no problem. She shared with the class that the realization signaled to her that she had not really created a story and sent her back to the drawing board. When asked to compare the task of writing a story with that of writing a research paper, teacher-students expressed that writing a research paper would have been much easier and much more comfortable but that they would have perceived it as just another assignment. They expressed a real commitment to and personal investment in writing their story.

Reflecting on the Alternative

Although not universally effective in promoting teacher-students' ability to fashion an image of technology integrating schools, the narrative mode of thinking served as an important strategy toward accomplishing this goal. In addition, this study pointed to two components essential for the strategy to be effective. First, teacher-students must be guided through robust reading, reflecting, and modeling activities prior to attempting to create their stories. Second, even though many of these teacher-students teach story writing themselves, they need significant support and instruction in the nature of story and story-telling before they are able to capture the power of narrative as a way of making sense of their emerging knowledge.

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Is There Really Life During Statistics?

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Studies (Fennema & Sherman, 1976; Koohang, 1989; Loyd & Gressard, 1984; Norton, 1992) have shown that anxiety toward a subject area may affect the learning process and actually become a deterrent to learning. If positive attitudes increase, students can master the skills involved which then offer many advantages in the educational process.

In the fall semester of 1993, three graduate students, Leona Dvorak, Elizabeth Willis and Karen Tidler, "fell" into a research project with University of New Mexico statistics professor Dr. Joseph G. R. Martinez. During the previous semester the three of us met in Dr. Martinez's Educational Foundations 603, a graduate level quantitative statistical inquiry class required of Ph.D. students. Like most of our peers, we suffered from a high level of anxiety, thinking there must be a better way to approach the study of statistical concepts and analyses. Often we discussed how a problem-centered, cooperative learning environment might significantly reduce the anxiety traditionally associated with math/statistics classes in the social sciences, and, perhaps, thereby increase the level of performance. Our determination to reduce the pain (at least ours) of advanced level statistics led us to develop a research project.

Our original plan of investigation was to innovate the instruction of one of two available sections of Educational Foundations 501, an introductory graduate level statistics class. Dr. Martinez was teaching both sections, and one could be utilized as a control group; the other as a treatment group. In the treatment group we wanted to implement small learning groups in which students designed studies and planned analyses, learning by "doing" and "being" researchers and statisticians. Subjects in the control group would experience the traditional "stand and deliver, then test" method of teaching.

Additionally, we wanted to determine if demographic variables, such as age, gender, learning style, and ethnic background had any relationship to the perceived anxiety of the students in either of the classes, or their performance on tests.

Ah, how real life can change the nature of a study! The research finally metamorphosed into a study of the effects of three methods of tutoring, computer-based, problem centered, and open-ended. Did any of the tutoring methods increase test performance or decrease anxiety? And were any of the demographic variables interacting with test performance or anxiety? This evolution of the research plan itself is fascinating and indicates how important and necessary flexibility and willingness to view alternatives are in the educational and research process.

Instruments Used

We chose to use the 4MAT Learning Type Measure (LTM) for our learning style inventory and the Hemispheric Mode Indicator (HMI) to inventory right and left brain approaches to learning. The copyright for these instruments is held by Excel, Incorporated.

We developed a demographic survey to collect information regarding student age, gender, ethnicity, current computer skill level, and anxiety level on entry into the statistics class. Test anxiety level was reported using an anxiety scale developed by Dr. Joseph G. R. Martinez.

Procedures

The subjects completed learning style and demographic surveys at the beginning of the semester. We each tutored a group of students one hour per week for the Spring 1994 semester. Throughout the course of the study students answered questions about their anxiety on test questions, as they were taking the exam. As tutors we kept journals of the events in our groups and our reflections on the tutoring experience.

What Happened: Challenges

Reading over our journal entries for this research project brought back memories of the hectic time we had and the feelings of being completely overwhelmed by the logistics of introducing the study in the classes, pretesting, and assigning subjects to tutoring groups. We had NO idea how all that could or even would happen.

> The learning styles measures did not arrive at UNM until after noon today, so we were in sort of a tizzy. However, we put the packets together just before class at 4:00. Joe introduced us after discussing the study and we helped administer the tests (Willis, unpublished journal entry, January 20, 1994).

The above entry hardly describes the "tizzy" we were in, calling the company, calling United Parcel Service, and calling Dr. Martinez to warn him that we might not be ready for the opening class! The students in that class probably never guessed from our smiling, calm faces what we had been through that day; true teachers, acting as if we introduced research every day of our lives and knew exactly what we were doing.

Our plan was to have the 501 students register for tutoring the first day of their class. We would then set up the tutoring times that best suited the majority. Students would be randomly assigned to one of the three groups, and we, as the tutors, would randomly rotate through the sessions. That SOUNDED like a good plan, but we had no way of knowing whether it would work or not. As it turned out, luck was with us, and all participating students in both classes were able to fit one of the three tutoring sessions into their busy course schedules.

> All this scheduling, which, at first seemed like it would be a nightmare, has been incredibly easy. Seventy people have been able to fit into three time slots (Dvorak, unpublished journal entry, February 5,1994)!

Because we had decided to incorporate Computer Aided Instruction as one of the tutoring methods, we needed a basic statistics application to use, which we did not have. Quite by accident, Leona and Elizabeth came across the *EZQuant* statistics program which had been co-written by Dr. Sam Hicken, a professor in our department, and convinced the director of our computer lab to purchase 15 copies. Again, we proved the old adage that "who you know is more important than what you know."

> Last week I became dissatisfied with the way *EZQuant* addresses our tutoring. Now the question is 'What to do about it?' My dissatisfaction is that the *EZQuant* exercises are not closely tied to the class work that is going on in the classroom. I'm trying to create the tie between the classroom happenings and the work we are doing using the software. I guess I feel responsible for a close connection between the two. I feel overwhelmed by the thought of developing the tutoring exercises to fit the classroom (Dvorak, unpublished journal, February 22, 1994).

What We Found

We ran correlations and multiple regressions to determine relationships among variables and factorial ANOVAs to investigate differences in the means before and after tutoring. Our findings? Math anxiety was so pervasive our treatment made no difference. Our students started out anxious and stayed that way. So did we!

How We Felt

Our journal entries, which we maintained throughout the study, indicate that we as teachers were profoundly affected by our peer tutoring experience; perhaps more so than those we tutored.

> The students were still asking theoretical questions. I don't always have the answers. I don't like not having the answers but I don't have that kind of experience either (Tidler, unpublished journal entry, February 14, 1994).

> No theoretical questions tonight. Since this has been a weak area that I haven't been able to answer it is interesting. Instructors do guide the type of classes they have (Tidler, unpublished journal entry, February 28, 1994).

> Talking to Leona about tutoring, we again agreed that statistics instructing should be changed completely to be a block which incorporates theory and hands-on building of a data set. I shared with her that I still feel as if I'm confusing them more than I'm helping. I'll ask them next time. Sometimes I'm not any surer of the concepts than they are (Willis, unpublished journal entry, March 24, 1994)!

> Class went well. They are frustrated that they don't know where to use this material—this presents the project approach for instructing statistics (Tidler, unpublished journal entry, April 25, 1994).

> I sometimes don't feel confident in my ability to tutor statistics. Maybe I'm trying to "know too much." I think I'll chill out a bit, plan but not overkill, and see what happens. I always feel bad if I can't answer a question, or if someone answers it better...but that's really the point: to engage the students in their own learning (Willis, unpublished journal entry, February 24, 1994).

> Several students indicated that the tutoring sessions were helping them in the class. That's good to know, since I still feel less than confident in my ability with statistical concepts (Willis, unpublished journal entry, March 11, 1994).
>
> The students didn't seem to share my feelings of confusing them more than helping them... as I often did feel. One gave me a small pillow she had made for me with potpourri inside—nice of her. Can't believe that it's over—a couple months ago I didn't think it would EVER be over (Willis, unpublished journal entry, April 28, 1994)!
>
> What an experience...I wouldn't have missed it for the world. It taught me lots about myself and my reactions to "not knowing the right answer." I learned again that people are people, no matter what (Willis, unpublished journal entry, May 5, 1994).

"Ought" Versus "Is"

Initially we set out to try an alternative method of teaching in one of two statistics classes because we believed that a problem-centered, cooperative-group approach would result in less anxiety and better performance as well as deeper content understanding.

At the end of the study, even though the study itself was different than originally conceived, and after all the tutoring and testing, we still believe that students in beginning statistics courses would be better served by classes in which they investigate "real" problems by "being" researchers: "doing" their own small studies, designing surveys and collecting data, then learning the appropriate statistics to run, instead of reading about the work of others, and taking notes on a three-hour lecture.

> Students brought up their concern that they learn to do the math, but it soon is forgotten! They want a real-life application for what they are doing (Dvorak, unpublished journal entry, March 26, 1994).

Future Research

Perhaps anxiety is such a pervasive construct that more time is needed to "attack" it. A semester, three months, is a short time, especially for adult learners, in which to change a lifetime of feelings. Dr. Andrea Vierra, a professor of statistics in Educational Foundations at the University of New Mexico, has suggested to us that this might be true. In an interview with her, she told of how she conducted a study over a two-semester period in which students participated in a block class, doing group work, and learning to run statistical tests on the mainframe computer. Results, however, were the same: no significant difference in anxiety or performance between those students in her study and those attending a "regular" class.

More research is indicated, over longer periods of time, to determine if alternative teaching strategies change student attitudes and depth of learning in graduate statistics classes.

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Basic Criteria for Selecting and Evaluating Instructional Software

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Recent advances in computer-based instructional software have been dramatic both in quantity and quality. Producers of software have made large strides toward creating software that serves specific educational goals instead of directing those goals. A second major advance has been in the degree of learner interactivity offered, thereby providing greater learning for students and taking greater advantage of the capabilities of the computer. The selection and evaluation criteria discussed in this article are designed to aid practicing educators in dealing with the dilemma created by the proliferation of quality instructional software available today.

Caffarella (1987) presents a thorough evaluation model that emphasizes student learning as the ultimate criteria. Software packages today offer teachers the opportunity to change how teaching and learning occur in their classrooms. An Educational Software Evaluation Consortium survey of members resulted in a list of 22 critical evaluation criteria. These criteria ranked content, organization, and sound pedagogy over computer-related issues (Bitter & Wighton, 1987). Simonson and Thompson (1990) recommend that judgment criteria fall in three categories: content, utilization considerations, and administrative considerations.

In any case, there is a growing need for practicing educators to select software that makes better use of the instructional capabilities of computers. A study by Callison (1987-1988) found that the variability among raters of instructional software appeared to be related to three factors: awareness of similar packages for comparison purposes, personal computer experience, and the actual time spent in the evaluation process. In order to optimize the instructional capabilities of current software, educators need a clear and practical model for appropriate software selection and evaluation. The model proposed in this paper consists of six rating factors: the *Instructional Factor, Computer Appropriateness Factor, Program Techniques Factor, Cost/Benefit Factor, Overall Evaluation Factor,* and *Hardware Requirements Factor.* Emphasis is placed on the instructional factor as critical to the integration of instructional software within existing curricula.

The term *"computer-based instructional software"* is used to encompass both computer-assisted instruction (CAI) and computer-based training (CBT). Specifically, the traditional CAI taxonomy is based on what the software does and includes these categories: 1) drill and practice, 2) tutorials, 3) simulations, 4) instructional games, and 5) problem solving (Lockard, Abrams, & Many, 1987).

Alessi and Trollip (1991) argue that for effective instruction to occur, four basic phases must be present. These phases are: 1) presenting information, 2) guiding the student, 3) practice by the student, and 4) assessing student learning.

Criteria for Software Within the CAI Taxonomy

The model which follows is intended to summarize criteria for selecting and evaluating instructional software within the CAI taxonomy. Criteria are grouped around the four basic phases of instruction. The purpose is to provide a framework for practicing educators as they work to integrate computer-based instruction within their curricula. There is strong agreement that computer-based instruction is most effective when used in conjunction with other instructional strategies, but the software choice may heavily influence the choice of supporting instructional strategies.

Drill and Practice Software

Instructional factors to be considered for drill and practice software include:

For presenting information:
- appropriate for particular audience
- clear, adequate directions for the learner
- appropriate graphics, sound, and color for learner motivation and perception needs
- review of prerequisite knowledge
- learner control of presentation rate
- vocabulary is age and content appropriate
- learner control of stopping, pausing, continuing, restarting

For guiding the student:
- availability of help options
- random items
- feedback that is positive and corrective
- item quantity does not exceed limits of learner memory
- cueing used as one type of feedback
- response time limits appropriate

For practice by the student:
- item difficulty on a progressive continuum
- items grouped by difficulty level
- intelligent judging of response
- appropriate learning theory and pedagogy for the instructional goal
- content is accurate

For assessing student learning:
- summative assessment included
- data storage for item selection, correct responses
- reporting mechanism for student progress

Tutorial Software

Instructional factors to be considered for tutorial software include:

For presenting information:
- appropriate for particular audience
- clear, adequate directions for the learner
- acceptable methodology for presentation of the content (linear or branching)
- prior knowledge stimulated
- appropriate content scope and sequence
- limited learner control

For guiding the student:
- appropriate length of content presentation
- varied student responses necessary
- text layout appropriate
- appropriate use of instructional prompts

For practice by the student:
- items measure content progress
- color, sound, graphics included to hold learner interest
- learner control of viewing prior screen(s)
- learner control of stopping, pausing, continuing, restarting
- intelligent judging of timed responses
- judges need for remediation
- feedback that is positive and corrective

For assessing student learning:
- record-keeping automatic
- student progress report accessible to instructor
- valid pre- and post-tests.

Simulation Software

Instructional factors to be considered for simulation software include:

For presenting information:
- appropriate for particular audience
- realistic, or at least possible situation(s)
- learner presented with meaningful, attainable goals
- directed at significant, not trivial, content

For guiding the student:
- extensive support materials available
- feedback which is natural or artificial; immediate or delayed
- learner control of stopping, pausing, continuing, restarting

For practice by the student:
- situations are appropriately random and unpredictable
- learner control of rerunning based on success or failure
- color, sound, graphics used to maintain learner engagement
- collaborative decision-making encouraged
- learner control of initial choices and returning to choices

For assessing student learning:
- data storage of decision-making paths explored
- data stored for amount of time learner was engaged.

Instructional Game Software

Instructional factors to be considered for instructional games include:

For presenting information:
- appropriate for particular audience
- clear, adequate directions for the learner
- clearly directed toward an instructional goal
- modes of learner interaction vary

For guiding the student:
- learner understands whether the game is one of skill or chance
- learner understands the constraints of the game
- learner control of returning to the directions

For practice by the student:
- collaborative decision-making encouraged
- team competition fostered
- color, graphics, sound controlled by the learner decisions in the game

For assessing student learning:

- summative feedback message, perhaps composed by the learner.

Problem Solving Software

Instructional factors to be considered for problem solving software include:

For presenting information:
- appropriate for particular audience
- clear, adequate directions for the learner
- clearly directed toward a narrowly-defined instructional goal

For guiding the student:
- appropriate content principles are demonstrated
- application of appropriate content rules
- limited learner control of sequence
- color, sound, graphics included to focus learner cognitive processing

For practice by the student:
- learner generates problem solution(s)
- learner generates procedures for problem solution
- learner controls returning to directions
- intelligent judging of multiple response possibilities
- corrective, varied feedback

For assessing student learning:
- data storage of decision-making paths explored
- data stored for amount of time learner was engaged.

This author proposes that a three point rating scale of zero, one, or two points be applied to each of the criteria above for compilation of an *Instructional Factors* rating. No evidence of the listed criteria would merit a score of zero. Some evidence of the listed criteria would merit a score of two. Extensive evidence of the listed criteria would merit a score of three. Tally these individual criteria scores for the *Instructional Factors* rating.

The Selection/Evaluation Model

The previous criteria are proposed to emphasize the instructional capabilities of computer-based software. In addition to the instructional considerations, educators must include other criteria in their evaluation and selection processes. Caffarella's (1987) evaluation guideline includes: a) consideration of the appropriateness of computers to teach the instructional objective, b) software program techniques, c) cost/benefit analysis, d) overall evaluation, and e) program supplier and hardware requirements. These criteria are now revised and updated for inclusion in this model.

Not all instructional objectives are most effectively addressed by computer-based instruction, even if the software exists to teach those objectives. Educators should consider which other media might be used to teach the same objectives. Once alternatives are considered, the software criteria are:
- the software is a reasonable use of a computer
- the software takes advantage of the interactive capabilities of the computer
- the software takes advantage of the color, sound, and graphics capabilities of the computer

Using the same three point rating scale described previously, score these three criteria with a score of zero, one or two and total these values for the *Computer Appropriateness Factor.*

Nothing is more frustrating for a classroom teacher than technology that does not perform as expected. A *Program Techniques Factor* can be compiled using the aforementioned three point rating scale. The criteria are:
- the software runs properly
- the software directions are clear for stopping and starting
- the software uses consistent commands and directions throughout
- the software is free of content errors
- the software does not omit important content

Determining the cost/benefit value for instructional software requires that the educator consider both learner time investment and actual cost. What is the average amount of time needed to complete the instructional package? the minimum time? the maximum time? What is the total cost for the software package or site license? Once considered, the educator places a subjective value on the anticipated benefits for the investment. On the three point rating scale: zero for low cost/benefit, one for acceptable cost/benefit, or two for high cost/benefit. This value becomes the *Cost/Benefit Factor.*

The *Overall Evaluation Factor* is determined by applying the three point rating scale to the following criteria:
- the software has been evaluated by other educators with high endorsement
- the software has been tested with potential learners and garnered high endorsement
- appropriate support materials are available for integration within the curricula
- the software objectives correlate highly with content objectives
- weaknesses in the software can be adequately compensated for with supplemental instructional strategies
- the software is a positive supplement to current instructional strategies
- the software should be adopted by our school

Finally, there are constraints of the software and hardware to be considered. The name, address and help-line phone number of the software supplier should be documented. Criteria for rating on the three point scale are:
- current hardware has adequate RAM for the software
- current hardware has adequate hard drive storage for the software
- current hardware has appropriate sound, video, color, and graphics capabilities for the software
- additional software is not required to make the most effective instructional use of the software being considered
- if necessary, networked versions or site licenses are available for the software
- budgets will allow for the purchase of upgrades as they are available.

Tally these criteria ratings to compile a *Hardware Requirements Factor.*

Conclusion

In summary, the selection/evaluation model proposed has six factors which can be weighted as the evaluator(s) sees fit. These factors: *Instructional Factor, Computer Appropriateness Factor, Program Techniques Factor, Cost/Benefit Factor, Overall Evaluation Factor,* and *Hardware Requirements Factor* combine to create a framework for decision-making and encourage an open discussion of the curriculum integration issues associated with selecting and evaluating instructional software. This model attempts to emphasize content and sound pedagogy as important criteria in software selection and evaluation. This author believes that instructional software can change how teaching and learning occur in classrooms. Hopefully, this model will help educators move toward that end.

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Training Teachers: An Introduction to the Training Component of the Houston Independent School District

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Houston Independent School District

The Houston Independent School District (HISD) has come a long way in one hundred years. The district went from educating 5,500 pupils in 1884 to an estimated 201,000 students in 1994. The district has a variety of student ethnicity with 49.2% being Hispanic, 35.7% being African American, 12.2% White, 2.8% Asian, and .1% of the students American Indian. The district has increased in size with the demand of these students from 40 square miles in the 1900's to 312 miles with 247 campuses in 1994. Complementing the increase in student enrollment, the total number of teachers has increased from 105 in the 1900's to 11,906 in 1994 ("About HISD," 1994).

Course requirements have changed drastically with the influence of technology in the schools. No longer are penmanship and stenography required elements for students. With the influx of computers in society, education has been forced to integrate technology into the schools so that students are better prepared for the real world. In order to educate students on how to operate a computer, teachers themselves first need to be trained. HISD has a Training Component of the Technology and Information Systems Department that is responsible for training teachers on the software programs that are available to them and to their students.

Training Objectives and Classes

The two main technology objectives of HISD are to increase student and employee contact with technology, and to decrease the amount of paperwork for employees while increasing their productivity time ("Long-Range Plan," 92-93). In order to implement these objectives, teachers need training on technology so they can then teach their students. With the variety of technologies available, teachers can reach students with different learning styles so that all students may receive a quality education. Teachers will also be able to complete their administrative duties faster, and thus have less paperwork and more time to dedicate to student needs.

Increasing employee contact with technology is accomplished with training facilities in three convenient locations throughout the city. The training labs consist of one Apple lab, three Macintosh labs, and one IBM lab with more IBM labs being added. The Training Component offers a variety of hands-on classes free of charge to HISD employees. A calendar of the workshops is published in the Superintendent's Bulletin for all employees to view. Any HISD employee can call the Training Component to register for classes. The phone system offers immediate registration and confirmation on a first-come-first-serve basis. The classes are conducted Monday through Friday during the day and in the evening, and on Saturdays to fit busy employee schedules. An introduction class is a prerequisite for all of the workshops. The workshops that are presented are based on employee need during that current school year. The following is a list of certain classes with descriptions offered by the Training Component. (Reprinted from the HISD Technology Training Fall 1994 Schedule of Classes.)

AppleShare (Macintosh Networking System)

Prerequisite: Overview of Local Are Networks

(Restricted to site-based network coordinators)
This workshop is designed for staff actually administering AppleShare networks. Participants will practice adding/deleting users, creating user groups, and installing software. Maintenance and security issues will be discussed.

ClarisWorks
Prerequisite: Introduction to Macintosh or IBM
This workshop allows participants to discuss the characteristics, advantages, and instructional applications of integrated software using ClarisWorks as the vehicle. Participants will practice using word processing and graphics components in parts A and B and database and spreadsheet components in C and D.

Excel/Part 1
Prerequisite: Introduction to Macintosh or IBM
This workshop will introduce participants to the Excel spreadsheet software. Participants will create spreadsheets, enter data, manipulate data, and graph data.

FileMaker Pro/Part 1
Prerequisite: Introduction to Macintosh
This workshop shows participants how to design, develop, and use the FileMaker Pro database program. Participants get experience in creating a database "from scratch" as well as editing and manipulating an existing database.

FileMaker Pro/Part 2
Prerequisite: FileMaker Pro/Part 1
This workshop focuses on layout considerations and reporting features of FileMaker Pro.

Geometric SketchPad
Prerequisite: Introduction to IBM
Participants will practice using the Key Curriculum Press Geometric SketchPad. Instructional applications will be discussed and demonstrated.

HyperCard
Prerequisite: Introduction to Macintosh
Participants will develop stacks using the object-oriented programming language. Its use in the middles school computer literacy curriculum will be emphasized.

Introduction to Computers (Chapter 1)
This workshop provides an overview of the operation, maintenance, and instructional uses of the Apple IIe, Apple IIGS, and Macintosh microcomputers. Copyright issues will be discussed.

Introduction to IBM DOS/Windows
This workshop covers the operation and maintenance of microcomputers. Participants will practice basic DOS functions. Participants will practice using the Windows' graphical user interface. Copyright issues will be discussed.

Introduction to Macintosh
This workshop covers the operation and maintenance of microcomputers. Participants will practice using the Macintosh graphical user interface. Copyright issues will be discussed.

Introduction to Multimedia
Prerequisite: Introduction to Macintosh
This workshop provides an overview of the instructional uses of multimedia devices. Participants will use laserdisc players, CD-ROMs, scanners, and related software.

Introduction to Wingz
Prerequisite: Introduction to Macintosh
This workshop will allow participants to create, manipulate, and print information using the Wingz spreadsheet software program.

MacSchool (School Management System)
Prerequisite: Introduction to Macintosh
Participants will discuss and practice using the Student Details, Attendance, Report, and Library components of MacSchool.

MediaMax
Prerequisite: HyperCard
Participants will learn how to use MediaMax to develop customized lesson plans controlling a laserdisc.

Microsoft Word/Part 1
Prerequisite: Introduction to Macintosh or IBM
Participants will create, edit, and print documents using the Microsoft Word processing program.

Microsoft Word/Part 2
Prerequisite: Microsoft Word/Part 1
Participants will practice advanced features of the Microsoft Word word processing program, including mail merge and table generation.

Overview of Local Are Networks (LANS)
Prerequisite: Introduction to Macintosh
This workshop will introduce participants to the operation and maintenance of LANS. Topics include network topology, operating systems, access, and security issues.

PacerForum
Prerequisite: Introduction to Macintosh
Participants will learn the basic features of the PacerForum bulletin board system. Instructional applications will be discusses and demonstrated.

TENET (Texas Educational Network)
Prerequisite: Introduction to Macintosh
Note: Participants must have an active TENET account. This workshop covers the operations of TENET, the state education network. Instructional applications will be discussed.

Tracker
Prerequisite: Introduction to Macintosh or IBM
Participants will learn how to implement and use Tracker for attendance reporting.

Winnebago Library Management System
Prerequisite: Introduction to Macintosh or IBM
Participants discuss library automation procedures and practices and learn how to use the Winnebago system.

Training Results

The training classes are reviewed by the district in an overwhelming success with outstanding attendance by employees. Several categories of employees have been trained including: principals, assistant principals, coordinators, administrators, teachers, secretaries/clerks, counselors, librarians, aides, and volunteers. In the 1992-1993 school year, 526 workshops were presented, with 4,353 employees attending. Teachers comprise the highest employee category with 2,023 trained followed by secretaries and clerks with 1,029. The class with the highest attendance was Introduction to Macintosh with 153 workshops presented. ("Summary Report", 92-93). Introduction to Macintosh had the highest attendance, presumably because it is a prerequisite for all other Macintosh classes.

In the 1993-1994 school year, 717 workshops were presented with 5,288 employees attending. The two highest categories were again teachers (2,375) and secretaries and clerks (789). The decrease in the number of secretaries and clerks trained from 1992-1993 is possibly the result of a low turnover rate. The Introduction to Macintosh again had the highest attendance of 168 participants ("Summer Report," 93-94). The number of workshops and participants is expected to continue to increase in the 1995-1996 school year. Table 1 shows the increases from the last two years.

Table 1
Training Results in the 1992-1993 and 1993-1994 School Years

	1992-1993	1993-1994
Workshops presented	526	717
Employees Trained	4,353	5,288
Highest Category Trained		
Teachers	2,023	2,375
Second Highest Category Trained		
Secretaries/Clerks	1,029	789
Highest Attendance Workshop		
Introduction to Macintosh	153	168

The training workshops have initiated a positive attitude toward technology among HISD employees. With many employees returning to take additional classes. An evaluation form submitted by the participants at the end of each workshop has revealed that employees view the classes as beneficial and are excited about technology. For example, one teacher stated that, "I hope I will have more training in the future," another said, "I look forward to participating in more of these classes." Of course there are criticisms also, like "The room was too hot," or "This class should be longer," which are remanded as soon as possible or addressed for future classes. The following is an example of the evaluation form presented to participants.

HISD Inservice Evaluation Form

One component of the total staff development planning and organization process is the evaluation of inservice programs. Your assistance is asked in evaluation the inservice session which you have attended today. It is not necessary to sign your name. Thank you for your cooperation.

Date: ______________________________
Inservice Site: Bureau of Technology
Name of today's inservice: ______________________

Instructions: Please circle the number which corresponds to your degree of agreement with each statement below. (A=Agree, SA=Somewhat Agree, NO=No Opinion, SA=Somewhat Disagree, D=Disagree) If you have no opinion, or is the statement does not apply, circle the number 3. Read each statement carefully.

	A	SA	NO	SD	D
1. The presenter(s) seemed will prepared.	1	2	3	4	5
2. The presentation(s) was (were) delivered clearly.	1	2	3	4	5
3. Materials used were appropriate to the topic.	1	2	3	4	5
4. The methods which were used (i.e., activities, modes of presentation) were effective.	1	2	3	4	5
5. Location of this inservice was convenient.	1	2	3	4	5
6. Location was adequately equipped for the inservice.	1	2	3	4	5
7. Knowledge gained today will be helpful in my current assignment.	1	2	3	4	5
8. In my opinion, objective(s) was (were) accomplished.	1	2	3	4	5
9. Overall, the quality of the inservice was good.	1	2	3	4	5

Use this space to make comments or suggest improvements in this inservice session.

____

____

Note: Reprinted from the HISD Technology and Information Systems Inservice Evaluation Form.

Other Types of Training

In addition to hands-on workshops, the Training Component offers two additional technology training options. One is the Train-the-Trainer Model. This involves a casual training session for school technologist so they in turn can conduct school-based training. HISD's Long Range Plan states this helps increase the number of trainers and keeps up with the demands of the district. Teacher training has doubled in HISD because of the teachers-training-teachers model. More trainers will lead to more trained employees, and thus more students will benefit.

The district also offers video-based training for some workshops. The video center is available for all employees who desire to learn at their own pace. The video-based training is a great way to review courses as well. Employees view the tapes during regular business hours at a convenient time, and they may view them as many times as they wish. Also, videos are sent to the schools for the employees to view. An example is *Gradebuster™ Mac: Making the Grade,* a video which proceeds step-by-step through the gradebook program. This video is at the schools for teachers to view on their own time. This allows the gradebook workshop time and space to be used for providing other workshops.

Future Prospects

The technology training is definitely on the "upswing" with more and more employees wanting to learn about technology. In addition, the district is gearing toward networking the schools. For the 1995-1996 school year, all schools in HISD will be utilizing the Schools Administrative Student Information (SASI) system to accomplish administrative duties in the schools. Training for this change starts in November of 1994 after the assembling of four Compaq computer labs. An estimated 1800 employees will be trained including: principals, assistant principals, coordinators, administrators, teacher technologists, secretaries/clerks, counselors, and nurses (H. Blalock, personal communication, November, 1994). Technology as a whole is exploding in HISD with more and more people "catching the wave" of the future. The future looks bright for technology in HISD, and the employees as well as the students will benefit.

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Walking Our Talk: Six Practical Technology Suggestions for Teacher Educators

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The research literature is replete with examples of the powerful effects teacher modeling has on students (Bandura, 1977; Copely, 1993; Good & Brophy, 1994; Scotter, 1994; Wittrock, 1985). It has also been pointed out that if what teachers profess is inconsistent with how they actually act, students tend to model their teacher's behavior rather than their spoken words (Bryan & Walbeck, 1970; Williams, 1992). If we are to produce a generation of teachers that will value and use new technologies for teaching and learning, then all of us involved in teacher education, not just those directly involved in the teaching of technology, must make an effort to "walk our talk" in regards to technology (Drazdowski, 1993; Falk & Carlson, 1992; Kline, 1994; Strudler, 1991). The old adage of "Do as I say, not as I do" clearly will not work. The suggestions which follow are based on the following assumptions: that the faculty member has access to a computer and appropriate software, and that the faculty member has approximately reached the "refinement" level of use of the innovation, that is the state in which the user is willing to vary the use of the innovation to increase the impact on clients (students or others) within their immediate sphere of influence (Hall, Hord, Rutherford, & Newlove, 1975), or the "integration" stage, where the individual sees a place in the instructional process in which the technology can offer a solution to a problem (Reiber & Welliver, 1989). So when colleagues inquire as to how they can begin incorporating computer technology into their courses, I usually make the following practical suggestions to get them started.

The Print Merged Introductory Class Letter

Using a basic integrated software package like *Microsoft Works* or *ClarisWorks*, it is an easy task to prepare a personalized letter that will greet students and review basic course requirements. Use your class roster to construct a simple data base containing fields for information like first and last name, major, status, advisor, and whatever else may be applicable from the information available. Then in word processing, compose your letter, using placeholders (most programs have a "merge" function) to include information from the database in specified places, for example, using each students first and last name in the salutation. By using the print-merge feature, you can now sit back and let the printer generate a personalized letter for each member of your class, to be distributed at your first meeting. Such a letter can also be used to collect more data on students for future use in a class database file (see suggestion two). Include a short questionnaire section in the letter, including categories like local address, campus mail box number, phone number, e-mail address, and research interests, then collect the letters in the next class. Besides starting to construct a positive classroom climate from the very first day, you have also modeled one effective use of computer technology for your preservice teachers.

Construct a Class Database

If suggestion one was followed and the information was collected from the questionnaire part of the introductory class letter, the instructor could now enhance the previously started database file by adding this new information. Besides the categories mentioned above, other fields that an instructor may find valuable include such items as times available for study groups, those willing to car pool for field trips, building sites for early field experiences or student teaching placement, and research interests. As needed throughout the semester, the instructor can filter and sort through the database and print out various reports for class use. For example, since many courses stress a collaborative research project of some type, the category of research interests could be filtered to include those class members interested in like topics such as cooperative learning, inclusion, student motivation, or computer integration. These reports can then be distributed to the class members so that project groups can be formed.

Use A Teacher Utility Program

There are a variety of teacher utility programs that one can suggest to colleagues depending on their needs, for example, test generating programs, lesson planners, and electronic grade books that can produce individual progress reports. But a simple utility program that could be used almost immediately is a calendar maker program, such as *Calendar Creator* by Power Up! or *CalendarMaker* by CE Software. All courses need to deal with the reality of class time. A calendar making program can help neatly lay out the instructor's teaching plan for an entire semester. For example, when students in my general methods course are about to perform their microteaching episodes, I can produce a fairly detailed calendar that highlights who is teaching, who is responsible for collecting various types of data on the teaching episode, and who should be operating the video camera, with the calendar also reminding the students about various reading assignments and project due dates. Besides modeling a useful program, the instructor has also modeled part of the teacher planning process (Clark & Peterson, 1986).

Incorporate a Piece of Computer-Assisted Instruction (CAI)

All teacher education programs offer a variety of teaching methods courses, such as the teaching of math, science, language arts, or social studies. As Todd (1993) and others (AACTE, 1987; Wetzel, 1993) have noted, the entire teacher education curriculum needs to be redesigned to integrate technology into all courses so that students can see computers being used in relevant contexts. Method courses appear to be a logical starting point for this process. Many popular CAI programs that are utilized in K-12 education are available in relatively inexpensive lab packs, usually in sets of 5 to 10 program disks, that can be modeled by faculty and used by students enrolled in the courses. Some examples of software that can be integrated include, for math methods:

1. *NumberMaze* (Great Wave Software)
2. *Math Blaster Plus,* (Davidson and Associates)
3. *The Cruncher,* a talking spreadsheet, (Davidson and Associates)

For social studies methods:

1. *The Oregon Trail* (MECC)
2. *SimCity* (Maxis Software)
3. *SimTown* (Maxis Software)

For language arts methods:

1. *Creative Writer* (Microsoft),
2. *Reader Rabbit* (The Learning Company)
3. *Kid Works 2* (Davidson and Associates)

For science methods:

1. *Operation Frog* (Scholastic)
2. *BodyWorks* (Software Marketing)

Literally hundreds of other software options exist. A good source of information about what is working in the "real" world is your local school district or professional development school.

Create a Computer Supported Presentation

Wouldn't it be nice to put a little pizzazz into your opening day lecture and send a powerful message by supporting, say, your class syllabus with a computer generated presentation? Many colleagues are now curious about presentation software packages, especially after returning from conferences or workshops where their use is becoming quite common. As many authors have alluded to, these presentation software packages offer the presenter many advantages, such as impressive graphics, animation, audience handouts, and enhanced versatility of the presentation itself (Grandgenett, Grandgenett, & Topp 1994; Zeitz, 1994).

If colleagues are using an integrated application program such as *ClarisWorks* or *Microsoft Works*, first point out that each program has a simple, but limited, slide presentation function already built in. These programs allow the user to link a series of documents together to create a slide show, and include some transitional visual effects between slides. For more sophisticated presentations that can combine more powerful elements of multimedia, recommend a stand alone presentation software package such as Aldus' *Persuasion* or Microsoft's *PowerPoint*. Both packages have an easy-to-learn outline format and plenty of templates that allow even the novice user to be up and running in a very short time. After transforming their syllabus, suggest that the instructor review some of their favorite lessons or topics, and decide which ones may be even further enhanced by a computer presentation program. Or suggest that they start by focusing on just one course and give themselves the goal of supporting each traditional presentation with computer-generated support. With the construction of more multimedia classrooms on campuses and the increasing availability of laptop computers and portable liquid display panels for faculty use, more faculty seem willing to take advantage of this technology to enhance the teaching/learning process.

Explore the Use of Multimedia

A final suggestion for colleagues to consider is the use of multimedia in their teaching. Many quality commercial products, such as multimedia encyclopedias (*Grolier's, Compton's, Encarta*) and interactive videodisk programs

(*The Visual Almanac, Eyes on the Prize*, *The Great Solar System Rescue*), are now available that would integrate nicely into current education courses. But the real creative power and fun is in the use of an authoring program that allows the user to incorporate elements of text, sound, graphics, animation, and video to produce dynamic, interactive presentations. My personal choice for getting faculty started in multimedia production is *HyperStudio* from Roger Wagner Publishing. This program has a very friendly environment for nontechnical users, but plenty of advanced features for more serious developers. Though currently only available in Macintosh and Apple IIGS formats, a Windows version is under development. As with the use of presentation software packages, the increased faculty access to multimedia computers and production facilities and multimedia classrooms for display of their creations will hopefully create more demand in this area.

Conclusion

Change is always a difficult process, and paradigm shifts don't come easily. As Sheingold and Hadley (1990) suggest, it may take up to seven years of administrative support, staff development, and planning time before teachers fully integrate technologies into their repertoires. Though only a beginning, the six suggestions provided will hopefully assist in moving the process along. I agree with the conclusion of a recent article: the introduction of technology has given all of us, as teachers, the opportunity to become learners again (Means & Olson, 1994). Let's not squander such a golden chance.

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The Internet as an Interactive Medium in Graduate Teacher Training

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A common problem in current graduate teacher training programs is limited contact between teacher and student. At the root of the problem is the fact that most teacher training programs offer graduate level courses on a late afternoon or evening schedule. Most of these courses are offered on a one-day-a-week basis. This means, of course, that often a professor has contact with a student only fourteen or sixteen times in a semester. This severely limits the opportunity the professor has to communicate with the students and the opportunity students have to communicate with each other.

Collis (1992) suggests that *Computer-Mediated Communication* (CMC) can enhance student motivation, esteem, confidence, and cooperation. At the University of Nevada, Reno, we have made extensive use of Internet mail and have found it to be a successful way to establish CMC. The purpose of this paper is to illustrate, by summarizing our experiences with a *target course*, how a simple tool like Internet mail can enhance the quality of a teacher education course. We believe the quality of such a course is enhanced by vastly increasing the amount of student-to-student and professor-to-student interaction.

Assumptions Tested

The major assumption associated with our use of Internet mail to expand and extend class interaction is based on the success others have had using *Group Decision Support Systems* (GDSS), (Aiken, et al., in press). Aiken (1992) defines a GDSS as "a computer-based system typically implemented on a local area network in a single room" (p. 1). This type of system software, according to Aiken, "allows the group to collaboratively brainstorm, vote, modify text, and conduct other group tasks" (p. 1). Aiken has found the use of a GDSS especially useful in seminar type courses that involve brainstorming and sharing of ideas. Based on the GDSS idea, we made the assumption that Internet mail provided an obvious way to establish a GDSS type experience that could enhance group discussion, brainstorming, and the sharing of ideas for teacher training courses where opportunities for such activities were severally limited. It was assumed that Internet mail would provide a method of communication that could not occur in any other way (e.g., telephone conversations, additional class meetings, or written communications).

The Target Course

The title of the course upon which the assumptions of this paper were tested was *Microcomputer Courseware Design*. The course is an introduction to instructional development with an emphasis on incorporating technology into the curriculum. Each student was responsible for a course project that consisted of designing, producing, and evaluating a technology-based instructional package. The overarching theme of the course is The Potential of Instructional Technology for Changing the Teaching and Learning Process. The course incorporated a *role playing* element in that the class assumed the identity of an instructional design company with the professor as president and class members as designers and programmers. An introductory instructional development text (*Introduction to Instructional*

Development, by Castelle G. Gentry, published by Wadsworth) was used and class time was spent in discussing the content of the text, explaining and demonstrating various technical aspects of instructional design, and discussing individual projects, as they developed from rough ideas into final products.

Much of the richness of the learning experience in this type of course occurs when students are actually struggling with the hands-on development of their projects and the bulk of this experience occurred between class sessions when students had little or no direct contact with either the professor or fellow students.

Examples of Class Discussion via Internet Mail

In the beginning it was difficult to get the students to establish the habit of logging on and participating in the online discussion. Both in-class and online exhortations were made. The following is an example of a reminder from the professor to the students:

> I was happy to see that everyone made a log in and responded to my message. So far, however, I have only received one suggestion on our company name. Did I not give you this assignment last time?

The first wave of online communication centered around the selection of a name for our fictitious company. This brought about a lot of discussion, some of which was friendly banter, but marked the beginning of a cohesive group. An example of a message relating to this early stage of discussion follows:

> Dear Sir:
>
> The suggestions for our new company name are as follows:
>
> Indel Corp. (Coattail of Intel)
>
> A B C D (All 'Bout Computer Design)
>
> Sincerely submitted,
>
> Terry Owens

After the students became more comfortable with using Internet mail and as we got more into the course content, the discussion began to take on a more serious nature and the value of between-class discussion became apparent. The following is one of many exchanges between two students, shared with the entire class, relating to the selection of an instructional design project:

> Subject: Initial Idea for Course Project Assignment
>
> I logged in. I'm still trying to decide if I want to go with the budget issue that I brought up in class. I'm having second thoughts.
>
> Glenda
>
> Yes. Stay with the budget idea. I think it is very necessary, and such a great idea. I taught a budgeting class last year to seniors and have tons of materials left. If you need anything, please let me know.
>
> Terry

After the students had selected broad categories for their design projects, the professor was able to provide guidance as the students worked between classes. The following message represents a response by the professor to a student who only had a general idea of what her project would be:

> Good job of sending an initial idea. Let me respond:
>
> What format will your package take?
>
> a. It could be just a straight text, users-guide type thing.
>
> b. It could be text and graphics.
>
> c. It could be text, graphics, and video.
>
> d. It could be a an interactive training session using computer graphics in conjunction with a log on session.
>
> Option (d) above would be quite difficult but very interesting. This could make a nice package.
>
> What part of telecommunications will you focus on? I would select a few areas like: initial logon, pine for e-mail, and gopher.

The most powerful benefit of the between-class communication came about when students began sharing ideas and coaching each other. During an early class session, the assignment was made for each student to develop a detailed outline for his or her project. As is often the case, students left the class session with a certain amount of confusion about how the completed assignment should look and with some hesitation about starting it. One brave student's first draft of the assignment posted to the class, generated responses such as the following:

> Dear Janeen,
>
> WOW! Thanks for going first with a great example of the assignment. You've helped me decide how to do mine.
>
> See you Wed.!
>
> Terry

Some very interesting informal cooperative learning situations developed as the students got further into their projects. Pleas for help were posted and a great deal of between-class involvement among the students with one another's projects began to occur. An example of a posting that began a vigorous exchange follows:

> Hello INDEL members,
>
> I have been working on the outline of my project and come to you for information. The last section of my "information manual" will be on troubleshooting and suggested solutions.
>
> As you work on the Internet and experience difficulties or trouble spots or even find shortcuts or longcuts that make the work easier could you please write down the situation and solution and send it to me. I would like to include anything in this section that would help a fellow user find his way in the Internet world.
>
> Thanks.
>
> Kim

The degree to which cooperative learning evolved is further illustrated by an exchange between two students, where the first student wrote:

> Hello out there!!
>
> I had a wonderful time working on my project this weekend. I ran into a few glitches that I could use help on. I have yet to figure out how to smoothly take the user from Wordperfect to the terminal icon in Microsoft Works. Also, the user will have to toggle, using the alt tab keys in order to see the instructions and the Internet screen. As toggle is not a commonly used word, I have included a glossary in the booklet that will come with the program. Could someone give me a brief description of toggle? I know what it means but for some reason cannot come up with a description that is only a few lines.

A second student responded immediately with:

> Might I suggest that you use an analogy to help people grasp the meaning of toggle, such as: "Using a keystroke to toggle is similar to turning a light switch on and off."

In some cases very direct and specific help was received and shared. The following message was posted by a grateful student for help received informally by two of her classmates:

> Jim and Glenda,
>
> Thank you for solving the mystery of the Excel Function! For the rest of the Indeloids, Glenda and Jim sat down with me at the lab computer and after a few misses, hit on the correct sequence of using the correlation function in Excel! For your future reference, FORMAT the number type to be used, then highlight an empty cell (important step).

Communication did not end with the last class period. Some of the students continue to correspond with each other. A message that was posted a few days after the class ended emphasized the interactive element of the class, which was largely due to the use of Internet mail:

> This has been a terrific class with great interaction and learning!

Successes of the Target Course

There is no doubt in our minds that the incorporation of Internet mail into the target course made the course a richer experience for the students and the professor. Three positive results were identified by students through anecdotal situations and a course evaluation.

Class Cohesiveness

The positive aspect of incorporating Internet mail into the target course that was most frequently mentioned by students was class cohesiveness. All students commented that they felt they got to know the other students in this course better than they did in most other courses. They also commented on the fact that they felt the course took on the feeling of a real company where a group of people were working together to accomplish a common goal.

Cooperative Learning and Peer Tutoring

The feeling that the class became a cohesive group was partially the result of students sharing in each other's projects throughout the development process. The between-class interactions, where students were offering one another advice and forming informal groups to solve problems, in our opinion, accounted for much of the feeling of a close knit group. Beyond this, however, is the importance of the enhanced learning that took place. To browse through the accumulated messages throughout the course makes it obvious that having access to other students projects and becoming involved in offering suggestions and solving problems relating to other projects was an important aspect of the overall learning process.

Acquisition of Internet Skills

One of the most frequently mentioned positive aspects of the course by students was their acquisition of knowledge and skills relating to using the Internet. While this was not a specific course objective, it is certainly a serendipitous outcome. This positive outcome from the student's point of view also underscores the positive feelings teachers and prospective teachers have about the potential of the Internet as an educational tool.

Problems and Suggestions

Based on our experience with the target course discussed in this paper, the incorporation of Internet mail into a teacher training course is not without problems. Some of the problems we encountered along with suggested solutions are discussed in this section.

Initial Training

The first problem we encountered was the amount of class time it took to get the students comfortable with using Internet mail. Accounts were provided, and a presentation was made during the first class period. As the second class period began, it was discovered that only a couple of students actually knew how to use Internet mail and that the other students were eager to use it, but were harboring some anxiety about their ability to master the process. Therefore, a large share of the second class period was spent reviewing and demonstrating basic e-mail procedures. Once again, at the third class meeting, a torrent of questions were asked and additional anxiety was expressed about using the system. It wasn't until the fourth week in the course that all of the students were feeling comfortable with using Internet mail. The extra class time required for basic telecommunications training, of course, detracted from the course content and put the class seriously behind schedule. While the enhanced communication Internet mail provided was well worth the time and effort it took to establish it, such a course would be more effective if students came to the class with such skills already established.

Establishing an Internet Connection

In addition to students' lack of expertise in using Internet mail, some had difficulty establishing an Internet connection. Some students had home or classroom computers with modems and simply lacked an Internet account and some basic telecommunications skills to begin extending their class participation beyond the class time. Others, however, had no access to the Internet except at the College of Education computer lab. In cases where these students only came to the College of Education on the evening when the *target class* was held, they were excluded from any meaningful between-class communication. As these students began to see the value of using Internet mail, they either acquired modems for existing computers or acquired full computer systems. A good share of the informal cooperative learning activity evolved around students helping each other establish their Internet access.

Establishing the Telecommunications Habit

Even after all students had established an Internet connection and felt comfortable using Internet mail, it was difficult to get them to log on and interact on a regular basis. While they all had good intentions and saw the value of such participation, they reverted to established habits and allowed most of the time between class periods to elapse before thinking about joining in on the ongoing dialogue associated with the class. This problem was gradually overcome by constant reminders from the professor. Each class period began with a synopsis of the between-class dialogue and ended with an exhortation to log on early and frequently before the next class period. As the course progressed, the frequency of student participation increased and hit its zenith toward the end of the course.

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Configuring Graduate Coursework for Delivery via Internet

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Changing student demographics, university budget cuts, and the availability and economy of sophisticated communications technologies have precipitated unprecedented reforms both in the instructional methodologies and in the program delivery configurations of higher education (Kearsley, 1993).

Higher education is increasingly viewed as a service industry by a population of student consumers, many of whom are career transitioning adults from culturally and geographically diverse circumstance, expectant of convenience, and increasingly technologically astute. In this climate, higher education has been forced to compete as never before for quality students. At the same time, colleges and universities have experienced significant cost increases and a serious abatement of funding. To compete effectively, academic programs, especially at the graduate level, need to deliver programming to larger, more diverse, expectant, distant audiences, faster, more economically, and in accommodation of individual schedules (Barker & Taylor, 1993; Troutman & Kiser, 1994). For these reasons program innovation through the creative use of available communication technologies has become a popular vehicle for both the accommodation of a changing student population and for the maintenance of program quality (Mitzell, 1994). A report by the Washington State Higher Education Coordinating Board (1993) suggested that use of distance education technologies will reduce the need for off-campus construction and faculty as well as facilitate information sharing, increase collaboration among education agencies, stimulate timely reforms in academic programs, and in teaching techniques. The direct benefits to students of distance education technologies include access to academic programming which would not otherwise be readily available and the establishment of a "tele-smart" citizenry, comfortable with the use of communications technologies.

Satellite delivery, audio-graphics, video– and tele–conferencing, commercial bulletin boards, and more recently, the Internet, have been used with increasing frequency by colleges and universities to deliver entire degree programs (Barker & Taylor, 1993; Kearsley, 1993; Mizell, 1994). Indeed, the growing feasibility of a virtual university that maximizes technology to the mutual benefit of the institution and the student has fueled an unprecedented demand for, and development of nontraditional program configurations and distance education.

Because of its near universal availability, expediency, and economy, the Internet has attracted the interest of education agencies world-wide for its potential as a vehicle for the delivery of academic coursework, particularly at the graduate level. A most significant advantage of Internet based coursework is the ease with which it accommodates the individual schedules of a geographically diverse audience (Barker & Taylor, 1993). In addition, Jacobson (1994) suggested that one of the expected benefits of delivering a course via the Internet is that students who are reticent in traditional classes may be more willing to participate via the electronic medium.

The effective practical use of the Internet for course delivery however is less substantiated in reality than praised for its potential. To date, it appears that the results of efforts to offer coursework via the Internet have not been well documented in the literature for consideration by the academic community. Nor does there appear to be an experiential based familiarity with the use of this technology for course delivery among proponents of educational technology. This was evidenced when, in preparation for this article, a solicitation for information concerning the use of the Internet for course delivery was made through a major research organization's listserv. The majority of respondents acknowledged both the positive potential of Internet coursework as well as the current lack of data by which to plan and ensure its successful implementation. Information that was available in the literature and the insights shared through e-mail correspondence provided a basis for the development of the applications model for the delivery of graduate coursework via the Internet which is presented herein.

The development of an Internet course at Northwestern State University came about as a means of accommodating graduate students who are participating in a two summer graduate degree program at the university. Through this program students can complete a master's or specialist degree in selected emphasis areas within a two summer period. During each of two consecutive ten week summer sessions participants in the program complete twelve semester hours of coursework while in residence at the university. In order to finish the degree requirements by the end of the second summer session, students must transfer in six to nine semester hours of acceptable coursework or complete these hours on site during the regular academic year. Many of the students who attend the summer program come from remote areas of the country or from foreign countries where transferable coursework is often difficult to obtain. The availability of inexpensive online coursework that conforms to the expectations of the degree program benefits the university and is convenient for the student.

Course Delivery Model

An operations model was developed that would help ensure the efficient use of university technological, research, and personnel resources and ensure the student a quality academic experience. The model, once adapted by the university, was expected to remain relatively predictable in its configuration but adaptable to different course offerings. To this end, a model for the delivery of graduate coursework has been proposed.

Prerequisites

As a prerequisite to enrolling in an Internet delivered course the student must demonstrate proficiency with the basic computer skills necessary to participate in the course. This can be done through the successful completion of a Internet usage course/workshop offered on campus during the summers or by successfully testing out in a proficiency trial offered over the Internet at designated times during the year.

Online Orientation

Students who have registered for the course will receive conformation of such by mail along with hard copies of any materials that do not lend themselves to e-mail transmission including text books or other copyrighted materials. Students will also be provided the access address and activation date of the class bulletin board. The course syllabus which includes the course calendar, course expectations, and communication schedule will be made available to the students as a part of the online orientation through the bulletin board. Individual student accounts, the technical support resource account, and the instructor's account addresses will also be included in the orientation.

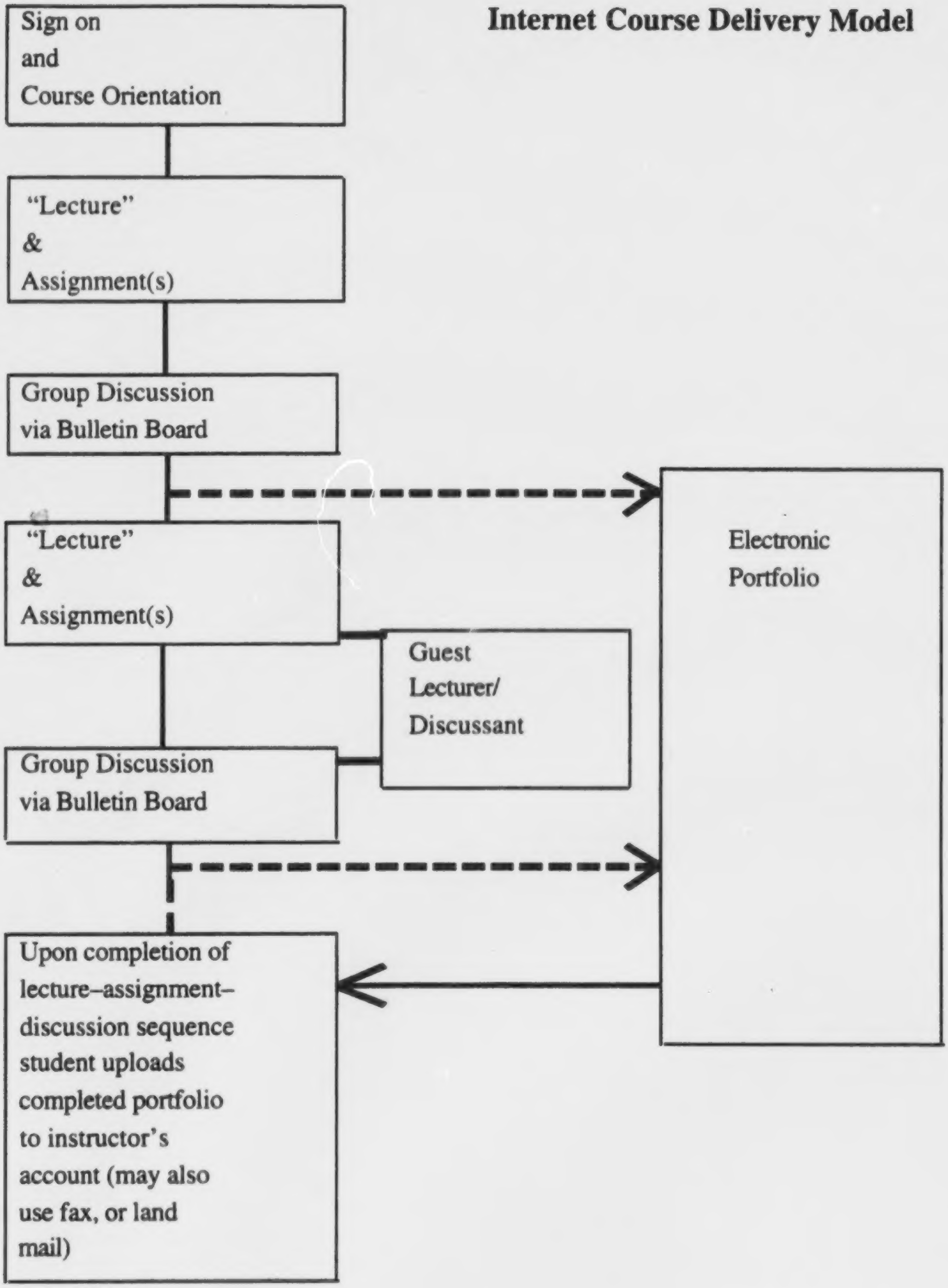
Lecture-Assignment-Discussion Cycle

The lecture-assignment-discussion cycle is the primary operations format of the proposed model. Lecture information and questions are first disseminated to students from the instructor on the bulletin board. Preferably the lecture-assignment phase will be conducted in real time, allowing students the opportunity to ask questions and/or discourse with the instructor and other students relative to the information covered or task assigned. An alternative, however, is to simply post the instructional information and associated assignments for the convenience of the students. While the latter is perhaps not the most desirable alternative, it does accommodate student schedules and time zone difficulties. Sometime following the lecture (information dissemination) phase, the bulletin board will be made available for follow-up discussion, for sharing experiences or research findings with regard to the topic and assignment, and for input and elaboration by the instructor. The bulletin board exchanges, as with the lecture, can at some interval be in real time. That is, a specific period of time can be designated as a real time exchange forum when a wrap-up of the previous days' exchanges is coordinated by the instructor. This wrap-up period could be conducted as a conclusion to the discussion phase and preliminary to the beginning of a new lecture-assignment-discussion phase.

The degree to which each student is expected to contribute to the bulletin board is best determined by the instructor. It is important that students understand that the bulletin board is a type of public forum, not to be confused with a mailbox for unrelated exchanges between individuals or small groups. There is potential in the use of the board to facilitate cooperative learning among the participants. In this regard, the board is used not only to elaborate or explore the academic topics but as a vehicle for the exchange of ideas and sharing of information among the students with regard to the task of completing specific assignments.

As planned by the instructor or as elected by the students guest lectures/discussants with special regard or knowledge of a topic can become involved during a lecture and/or follow-up discussion. Defining the compensation for these "guests" will no doubt need to be worked out well in advance.

Internet Course Delivery Model


Sign on
and
Course Orientation
"Lecture"
&
Assignment(s)
Group Discussion
via Bulletin Board
"Lecture"
&
Assignment(s)
Guest
Lecturer/
Discussant
Group Discussion
via Bulletin Board
Electronic
Portfolio
Upon completion of lecture–assignment–discussion sequence student uploads completed portfolio to instructor's account (may also use fax, or land mail)

- •Use of the bulletin board is restricted to class topics
- •Student–instructor consultation is through individual e–mail accounts
- •Limited tech support made available through special account to registered students only.

Electronic Portfolio

Upon their completion, required text-oriented products that demonstrate a student's understanding of a concept or mastery of a course related skill can be forwarded to the instructor's account for evaluation and later feedback. These products can also be used as a part of an electronic portfolio that is maintained by the student for the duration of the course. Upon completion of the course, the portfolio is forwarded to the instructor via e-mail, disk or hard copy. The exact nature and content of the portfolio is determined by the instructor and elaborated in the syllabus.

Technical Support

An account, through which students register for the course and can secure basic technical support, will be established and online several days prior to the initial sign-on date. Although participants in the Internet course will have to demonstrate proficiency with the skills necessary to work with the Internet, there will inevitably be technical difficulties especially during the sign-on and early use of the bulletin board. Technical support will be provided by the university computer center. Real time contact through the Internet with the computer center staff will be available at designated times during the life of the course. Mail left in the technical support account will be acknowledged on a periodic basis as determined prior to the scheduling of the course. Support will also be available by phone to students during designated times.

Implementation Parameters

The proposed model for the delivery of graduate coursework using the Internet will be implemented and tested during the coming academic year. Currently parameters put on the delivery of distance coursework by regional and national accrediting agencies and the operational realities which characterize the model are being examined both at the university and state levels. In addition, the establishment of a research effort that will objectively examine the academic and operational effectiveness of the model is a prerequisite for its implementation.

At this time there are significant concerns with the use of the Internet for course delivery. Real time delivery becomes increasingly difficult as the participants in the course become more geographically dispersed. In addition, the text driven communications to which the exchanges are limited make for a rather one dimensional academic experience. Lack of secure bulletin boards and the ease with which individual accounts can be breached may force a form of self-censorship onto students that may not be found in the regular classroom. Many of the problems currently associated with the use of the Internet for the delivery of coursework, however, will be resolved as the technology evolves and as the expectations of the users of that technology are more clearly defined.

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AV to Internet: Integration of Technology in Education

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As we stress the integration of technology into education, many faculty and students readily acknowledge the importance of its use. However, few know how to incorporate technology into their own teaching or use (for a general discussion of classroom computer usage, see Taylor, 1980; still very applicable). Both groups, preservice education students and teacher education faculty, must become *aware* of what is available in technology resources (e.g. CD-ROM, programs, laserdisc) in their content, subject, or grade. Then technology must be *modeled* for them to show how the hardware and software is set up and used. After the initial exposure and they are aware of available resources and have seen some modeling of technology, they are ready to *select* technology resources to use. This includes both hardware and software selections and how they will be used by an individual or group.

The ASSURE model (Heinich, Molenda, & Russell, 1993) facilitates this step because it keeps the developers focused on what they want to accomplish with the technology. At the completion of the selection process, they are ready to integrate technology into their teaching and shift the focus to a *support* function. This includes the setup and use of the equipment in class. Several trained mentor faculty and students in the department are available to assist.

Preservice education students go through this process in our Education 303 Instructional Technology course as they create a presentation to show to the class. Faculty, especially in the methods courses are encouraged, assisted, and mentored in technology integration.

Conduct of the Basic Instructional Technology Course

The instructional technology course is located very early in the elementary and secondary teacher preparation program at Weber State University. It is one of the first four courses preservice education students take. The principles learned are followed up during the rest of the education program but specifically in the methods courses.

Rather than just teach the procedures and processes for developing instructional media out of context (other than completing the course successfully), preservice education students are directed to develop an in-class presentation using various technologies as appropriate. This provides motivation for students to learn about different technologies available: print and non-print; traditional and new. Furthermore, in their search for appropriate media to complement, supplement, or enhance their presentations, they need to become familiar with the technology that displays or produces the item. When potential media are located, they can use them as they are or modify them as needed. If media are not located or available, students are then encouraged to use the technology to develop their own.

To facilitate the assignment, the class is divided into groups of four to five, depending on the overall size of the class. Assignment to groups has been based on: (1) similar academic background and/or interest; (2) whether they are elementary- or secondary-focused; or (3) no particular criterion except for personal preference on the part of the students. Though not quantitatively studied, no significant qualitative differences have been observed among any of the group assignment techniques.

The assignment to groups also serves another purpose in the instructional design of the course—the use of a modified Jigsaw technique (Slavin, 1995). Rather than conduct whole-class instruction in the procedures and processes of developing instructional media, each group identifies a member who will serve as the "expert." These experts receive the instruction and are responsible for teaching the other group members. Individual assignments are designed to ensure individual accountability and learning. Furthermore, the group situation fosters *interdependence* among the members as they have to rely and depend on one another to receive instruction in order to successfully complete the individual assignments.

This modified cooperative learning strategy is used in the teaching of new technologies, including computers, laser disc players, video cameras, CD-ROM drives, scanners, and digital cameras. The smaller groups allow for more in-depth instruction and learning. Finally, students have an opportunity to experience a relatively effective strategy for teaching and learning which will be valuable in their methods courses later in the program.

The procedures for developing the traditional media are learned by the students themselves as they provide the steps and sequences as well as the applicable design principles. The traditional media have been defined to include, but are not limited to, items such as transparencies, posters, laminating, realia.

Collaborating with Teacher Education Faculty

A major aspect in the preparation of preservice education students is the modeling of appropriate technology usage in the courses taught by the teacher education faculty (Munday, Windham, & Stamper, 1991). For students to see technology usage only in the Instructional Technology course or with teacher educators who are proficient in technology is not sufficient. Technology must be modeled throughout the entire program and students must utilize technology whenever appropriate.

As involved as teacher educators are, it has been difficult to get faculty to use technology in their classes. As stated earlier, the technology is available—every faculty member has a computer in his/her office.

However, a number of factors have hindered effective use of technology in teacher education classes:

1. Faculty members are not provided adequate time to learn, explore, and develop the variety of media usage possible for their classes;
2. Faculty members may not have sufficient background knowledge, experience, or awareness in the variety of media usage possible; thus, they may not have a vision of technology in the teaching and learning process;
3. Faculty members may not have the interest nor motivation to learn the new technology or it is low on their list of priorities;
4. Faculty members may not even want to learn and may even have an aversion to the new technology.

Though it may be sacrilegious to suggest, perhaps it should be recognized that technology is not meant for everyone and that this is acceptable. Consequently, new approaches are presently being considered and/or implemented to begin the integration or infusion of technology in teacher education classes. A mentor faculty member, who is technologically literate, is assigned to a non-technological oriented faculty member in one of the methods courses offered in the teacher education program. Mentor faculty provide assistance in the following manner:

1. Show the novice faculty member the variety of technology and resources presently available in the department, along with examples of potential effective uses;
2. Model the use of technology in the novice faculty member's methods course;
3. Accompany the novice faculty member to a professional conference and provide guidance in attending technologically-oriented sessions and visiting the conference exhibits and displays;
4. Develop the desired technological usages for the novice faculty member.

A major drawback of the aforementioned solution is that it is time consuming to the department as faculty loads need to be adjusted to accommodate this model of professional development. However, a potential solution is being formulated in the form of a one-year internship. An advanced degree program in Instructional Technology at a sibling institution requires their students complete an externship. Such an individual, armed with the latest in effective technology use, will serve as a consultant to the novice faculty members in the department as described above. The successful extern candidate will teach, consult, assist, and help in the design of technology resources that meet the needs of faculty members.

Summary and Conclusion

The approach taken with both students and faculty involves the notion of context. Often technological skills are viewed as primarily a linear set of procedures and are generally taught and learned without any context in mind. For example, students may develop transparencies for an assignment, but not for any additional reason. Therefore, learning is not very meaningful. Students may learn the appropriate steps and procedures but will not gain a global understanding of the educational implications of what is being produced unless these skills are part of the larger instructional process. As we integrate technology into the instructional process, students need to see that media are selected and included according to a plan and not haphazardly placed within a lesson or instructional sequence.

The goal of preparing and conducting a presentation provides students with a meaningful context in which to explore, learn, and develop media. As students are locating potential media for use, they must keep in mind the objective(s) of their presentations, and the appropriateness and accuracy of the media. In other words, they learn to evaluate media. Will the medium work as it is? If not, can it be modified or changed? If not, how difficult would it be to develop an original medium to enhance the desired learning?

Consequently, students find that they are using the skills and knowledge discussed in the course and that this usage is in a meaningful and viable context. In fact, the experience approaches what they will actually do as classroom teachers when they decide how to use media in their instruction.

What has been briefly described may be viewed as a constructivist approach (Brooks & Brooks, 1993) to the teaching and learning of technology and instructional media. In many respects, this approach is also taken in training and educating the novice teacher educator.

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Establishing Institutional Partnerships and Reshaping Instruction Via Interactive Distance Learning

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Distance learning received an impetus in 1988 when the U.S. Congress passed Public Law 100-297 allocating $100 million to create the federal Star Schools Program to support distance learning efforts to benefit education (Withrow, 1990). Now, according to Beckner and Barker (1994), some type of distance learning program currently exists in all states. In fact, various regional partnerships have been created. For example, Texas, South Carolina, Massachusetts, and Oklahoma have collaborated to share resources and strengthen offerings (Jordahl, 1991).

Such a partnership exists between Arkansas State University (ASU) in Jonesboro and four other institutions. Telecommunications and this partnership have facilitated ASU's expansion of curricular offerings and delivery of instruction.

Rationale for ASU's Utilization of Technology

Distance education techniques, according to Holznagel (1988), offer promise to schools that need to provide instruction for students who are located in remote sites or need flexibility in time and/or location. ASU serves a growing population of rural, non-traditional students possessing these needs.

With the number of enrolled high school students decreasing and the impact of non-traditional students demanding greater educational access in this rural state, educators at ASU recognized the need for distance learning education. In fall 1991, ASU received a request from the Arkansas Department of Higher Education to establish a technical program at Ozarka Technical College in Melbourne, Arkansas. The Arkansas Department of Computer Services Telecommunications Division and Southwestern Bell concurrently were making plans to establish an electronic educational network connecting K-12 and higher education institutions. Eventually, this network would allow all educational institutions in the state to participate in the national and international networks. ASU leaders perceived this as an opportunity to be part of an innovative technological movement to meet student needs and thereby maintain a competitive edge in the market. Consequently, officials at ASU decided to join the national trend in distance learning in the fall of 1992.

Distance Learning Equipment

Satellite-delivered distance education has been the most widely accepted and used distance learning medium. Compressed video technologies using telephone lines and fiber optics, however, have received increasing attention by distance education experts (Beckner & Barker, 1994). With the assistance of the Arkansas Department of Computer Services Telecommunications Division and Southwestern Bell, ASU has installed a telecommunications video network using a compressed video codec (compression/decompression). The ASU hub has a multi-point switching procedure that determines the number of locations with which the hub site connects. This allows the transmission of audiovisual images among ASU and any or all of seven remote sites. Since each remote site has the same transmitting equipment as ASU, classes can originate at any location on the network.

Each transmission unit consists of a codec, an Elmo projection device, a touch pad, and a computer keyboard. Two side-by-side television monitors in a cabinet containing a directional capable of panning camera and a hard drive constitute the codec. The Elmo is an overhead projector with a camera in the head with focus and zoom capabilities. Projections of slides, x-rays, books, handwritten and typed materials can be displayed. Furthermore, pictures loaded in a slide tray can be retrieved during a lesson by using the appropriate pad function. The third element of the unit is the control pad/draw board. By using a special pencil on the touch pad, the operator can control the cameras at local and remote sites, adjust the audio level, connect and hang up, advance the slide tray, activate the VCR and record classes. Finally, the computer keyboard allows faculty to type on the screen.

Off-Campus Partnership Sites

ASU has partnerships with four educational institutions in Arkansas. Using the telecommunications video system, courses are transmitted to students at the following sites: Ozarka Technical College-Melbourne, ASU-Mountain Home, Midsouth Community College-West Memphis, and ASU-Beebe, all of which are sites 60 miles or more from the ASU main campus.

Following joint meetings among the site agencies, a Memorandum of Understanding (MOU) was developed outlining the commitments of each site/agency in utilizing the telecommunications technology for course delivery. Significant issues clarified in the document include the following:

1. Student support services on the remote site
2. Staff and secretarial support services on the delivery campus
3. Provisions for on-site group recruitment and counseling regarding the courses being delivered
4. Acceptance of distance-learning courses as residence credit for degree purposes
5. Ownership of equipment
6. Responsibility for on-going line cost and maintenance
7. Secure housing of the equipment
8. A room acoustically and visually suitable for delivery of classes
9. Staff training in equipment usage

Utilization of the Equipment

The initial utilization of the equipment had focused on the delivery of undergraduate nursing programs. However, since 1992 other university offerings have been scheduled and broadcast on a first-come, first-served basis. In fact, unused time slots have been sold to other universities.

The Department of Educational Administration and Secondary Education is a primary user of the distance learning system. Since spring 1993, the department has offered a Master of Science in Education degree with an emphasis in curriculum and instruction in Mountain Home, a region in central Arkansas. This degree is a combination of on- and off-campus courses as well as courses taught from the ASU campus to Mountain Home students via distance learning. Of the 30 hours required for completion of this degree, students complete nine hours via distance learning: secondary school curriculum, school law, and supervision of instruction. These courses are provided simultaneously to students on the ASU campus, the point of origination.

Instructional Strategies

Many instructional strategies can be utilized in telecommunications video systems such as that used at ASU. The traditional methods of lecture, black line overheads, slides, and videos are quite compatible with this system. However, the three-second delay between the real time of the broadcast and the time the broadcast is received, hampers interaction among student groups at different sites. Students and faculty must become acclimated to this discrepancy. In delivering their courses, faculty of the Department of Educational Administration and Secondary Education use, in part, these methods. To provide more interaction among sites via distance learning, the faculty is exploring a variety of techniques. For example, in several classes students complete authentic tasks on site in cooperative groups and then share their products in formal presentations with other sites. In addition, students in pairs and small groups (one student from two or more different sites) communicate via the system during class and outside of class, use e-mail, phone, and fax outside class to complete a joint experiential learning project.

Conclusion

As is true of many institutions focusing on the 21st Century, ASU is embracing new technologies to fulfill learners' changing needs. Clearly, a major priority for the university is to enhance its distance learning program via forming institutional partnerships and staying abreast of technological advances. In addition, faculty face the challenge of effectively utilizing this technology concomitantly with proven teaching strategies, especially those facilitating experiential, problem-based learning.

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FACULTY DEVELOPMENT

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Computers will continue to drive change in the information age just as manufacturing did during the industrial period. In the 1900s [automobiles] and the 1960s [computers], "it was comfy to believe that such science fiction notions would never replace the horse and the assembly-line welder" (Naisbitt and Aburdene, 1990, p. 279). While the concept of interactive technologies are not new on university campuses, their use by faculty in schools/colleges/departments of education (SCDE) to strengthen teacher education programs have been rare. In this area, diffusion of educational change with technology is both complex and difficult. Hord and Hall (1987) theorize that "there is more to change than simply delivering the innovation "box" to the classroom door . . . rather a process is involved" (p. 7).

McNeil (1992) suggests five basic reasons why technology has not been adopted more widely and quickly by the faculty in SCDE: (a) attitudes - education faculty are intimidated by, fearful of, or indifferent to the new technologies; (b) training and support - given the intellectual barriers resulting from these attitudes, various technologies need to be taught in very small groups (one to one or one to two) in which faculty can comfortably ask questions without fear of peer pressure; (c) organization and structure - technology is taught more effectively by provocative, seminar-type discussions rather than traditional lecture; (d) marketing - education faculty needs to thoroughly understand the value of these various technologies for themselves and act as role models in order to convey this value to their students; (e) diffusion - when an educational innovation does not succeed, the fault lies with the process of implementation of the innovation rather than the innovation itself. In the case of faculty development, Odasz (1992) supports McNeil and stipulates that most teacher educators do not realize the power and advantages the technologies offer until they pass through four developmental stages - uncertainty, insight, internalization and enlightened expectation. Although this indicates a slow process, one thing is certain - educational change with technology in SCDE is moving forward.

This section documents a wide variety of issues and initiatives involving the integration of technology in teacher education programs. Downs discusses an innovative training series developed to prepare faculty to use the distance learning facilities at Georgia Southern University (GSU). Since faculty who are new to using distance education technology encounter many new issues in this non-traditional classroom setting, this discussion offers many helpful strategies. The author presents valuable suggestions on the use of equipment and facilities, material production, instructional planning, selecting media and methods, and evaluation procedures.

Hoadley, Engelking, and Bright details a reflective model for faculty development that includes technology infusion, support, and methods for faculty release time through time sharing duties. Though the authors admit that the marriage between technology and education will not happen unless teacher educators and other professionals in SCDE acquire access to technology. Once this hurtle has been met, teacher educators must model the technologies such that teacher education students can link the use of technology with effective teaching and learning practices. Their "restructured model emphasizes the learner's engagement in the educational process", thereby underscoring the many variables which effect learning outcomes. In a paper with a similar focus, McIntyre describes the mission and evolution of an entrepreneurial model developed to support faculty in learning technological literacy. This "Collegial Consultant" model was used to raise the information and technology level of faculty and assist them in the integration of technology into the curricula campus-wide. Due to the evolving nature of this model, it provides both instructional and research endeavors.

Mimes and Mc Kenzie describe going beyond the normal staff development model to train and retrain faculty and encourage them to use the newest equipment in their classes using collaborative teaching methods. The School of Education has taken the lead in technology training for the whole campus and encourage professors in all fields to attend these sessions. In addition, faculty has seen the importance of teaching preservice teachers to learn to cope with a global society.

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A Faculty Development Model for Distance Learning Systems

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Delivering courses over distance learning systems is becoming an important aspect of higher education. The distance learning system at Georgia Southern University (GSU) has been used to implement a variety of courses from among the colleges in order to meet the University's mission as a regional institution. As the use of the system increases, questions and issues arise regarding the implementation of the system. Many of the concerns involve administrative aspects of education. However, there are additional factors influencing college faculty's willingness to offer these types of courses.

One of the immediate issues faculty confront is the use of technology in a non-traditional classroom setting. Faculty are aware that the distance learning system presents challenges and considerations regarding methods of instruction used in traditional classroom settings. Therefore, College of Education faculty at GSU expressed a need to receive training to prepare them for using the system to deliver their courses.

A faculty training series was developed to prepare faculty for utilizing the distance learning facility. The training was presented in three different sessions: 1) Equipment and Facilities Orientation, 2) Materials Production, and 3) Instructional Planning. This was intended to familiarize faculty with the equipment, identify appropriate materials to use with the equipment, and identify instructional strategies that are effective with the distance learning system.

A handbook was developed to be used by faculty during and after training as a resource guide for distance learning. This manual was designed specifically for the distance learning system at GSU. The following is a summary of the information that was presented in the faculty distance learning handbook.

GSU Distance Learning Equipment

Audio

The instructor wears a small portable audio system. The instructor's audio system has a small microphone that attaches to a collar or lapel. This is connected to a small box that the instructor must wear. It can be carried in a pocket or attached to a belt. This system gives the instructor the flexibility to move around the classroom and maintain a consistent audio level. The audio system requires some practice to understand how the system works and how it responds to voice activation from the remote sites. The instructor's voice is broadcast to all sites simultaneously. When a student speaks, that audio signal is also broadcast to all sites unless the instructor chooses to MUTE some sites.

The majority of the rooms that are used as distance learning classrooms at GSU are equipped with hanging microphones for student use. The hanging microphones that respond to noise emanating from the student area. When a student speaks, their audio signal dominates the audio lines and is broadcast to all the sites simultaneously. In addition, the video signal is activated by the audio signal, and when a student is speaking, the video from that site is also being broadcast to the other sites.

Audio Suggestions

1. The portable microphone is very sensitive and therefore, it is important to use your regular voice. This might take some practice initially, as there is a tendency to speak louder when addressing the remote sites.
2. Avoid wearing any clothing or jewelry that might cause excessive noise especially near the area that you will attach the microphone.
3. It is important to remember that your voice is being broadcast to all sites as long as the audio system is in the "ON" position. Get in the habit of turning the microphone "OFF" at any point that you do not want to broadcast audio to all sites (small group work and individual site discussions).
4. In case of a malfunction with the lavalier microphone, the instructor can utilize the student audio system.
5. When students produce any sustained noises the audio is picked up on the student microphone systems and the instructor's audio is temporarily stopped.
6. The instructor can prevent student audio from being broadcast to or from the various sites by having the audio muted. This is especially appropriate during small group or class discussions which are not intended to be shared among the remote sites.
7. The audio system allows for only one person to speak for each audio system. If someone tries to talk "over" the instructor or someone at a different site, the audio is interrupted and cannot be understood.

Video

The video system requires practice in order to understand who sees what. The classroom has four monitors, two of which are used by the instructors and two by the students. The instructor monitors are usually placed where the instructor will be able to view them while teaching. On both the student and instructor monitors the left monitor displays the motion signal received from the other site and the right monitor displays the transmitted signal or the graphics signal.

The instructor's video camera is located in the back of the classroom. It is controlled by a facilitator who utilizes a control panel for camera movement. The camera can follow the instructor around the classroom. It can also be set at different camera shots. The instructor can request that the facilitator utilize close-up shots, medium shots, or long shots. A graphics camera is also available for instructor use. This camera is mounted on a stand so that written information, graphics, visuals, or three-dimensional objects can be viewed by the students.

Video Suggestions

1. At any time, you can ask for someone in a remote site to speak, this will activate the video from that site.
2. The facilitators can control the video from the instructor's classroom as well as from the remote sites. If you can determine special needs in advance, describe what you will need to the facilitators so they can be prepared.
3. Book time in the distance learning classroom to practice. You need to become comfortable with seeing yourself on the monitor. Practicing without students will also help you to become familiar with additional equipment such as the graphics camera.
4. Avoid the "talking head" syndrome. This occurs when you are constantly talking but there is no other "action" for students. Remember, you are using a medium which incorporates both audio and video. Use facial expressions, be dramatic when emphasizing points, use humor, be unique.
5. Remember that the students at the remote sites are viewing the images on monitors and they may be seated some distance from the viewing monitors. If you need to emphasize a point, it is best to ask the facilitator for a close-up shot or utilize the graphics camera and provide written information.
6. Avoid wearing any clothing that might overpower the visual image. It is best to wear solid color clothing if possible. Wear clothes that can accommodate the portable microphone system (something with belts or large pockets).
7. Some of the students may not be comfortable having their image broadcast over the video system. It is extremely important not to allow the technology to interfere with the course structure. Students might work with the facilitators at their site to discuss the types of camera shots that they are comfortable with.

Materials Production and Distribution

Materials for distance learning courses require special consideration for production and distribution. It is important to make sure that materials used with the graphics camera meet production standards since the materials will be broadcast and viewed by students over monitors. Distribution and collection of materials should be considered during the planning phase of the course design.

Production Suggestions

1. Print materials should meet lettering legibility standards. Choose a larger sized font that would be appropriate for the amount of information you are presenting.
2. When selecting lettering fonts for text information, select a sans serif style font.
3. Select one font per graphic. It is distracting to the reader to view several fonts on one page.
4. Images used with the graphics camera should be prepared with large fonts. Remember that students are viewing the graphics image over a monitor.
5. Graphics images should be produced in a horizontal format. Due to the format of the video monitors, other information will be lost. Allow for adequate margins when producing graphics for the graphics camera.
6. Images for the graphics camera should be limited to five or six lines of information per page.
7. Apply the simplicity rule in the design of graphic visuals. Summarize main points rather than providing details. Detailed or lengthy verbal information should be included in a handout for students.

8. Do not use all caps when producing graphics. It is too difficult to read. If you need to highlight a title select a larger type font to set it apart from the rest of the information.
9. Avoid hyphenation. Readers are distracted by hyphenation and it can cause a lack of continuity for the reader.
10. The graphics camera is ideal for demonstrating three dimensional materials.

Materials Distribution Suggestions

1. Each classroom has a FAX machine and a telephone. If time is an issue, materials can be faxed to and from students at the remotes.
2. In addition to faxing, materials can be sent to the remotes via the mail.
3. Allow ample time for distribution of materials to various sites. Planning is everything. You need to anticipate how you will send and receive student projects, course handouts, tests, instructional evaluations, and other instructional materials.
4. The facilitators are available to distribute materials at the sites. Make sure you code or number the handouts to simplify materials distribution for the facilitators.
5. The facilitators can also help collect materials that need to be sent to the instructor. Each step is dependent on other people and requires time. Keep this in mind as you are setting deadlines for student projects.

Instructional Planning

The Learners

The most important component of any instructional setting is the learner. All aspects of instruction will hinge on knowing who the learner is. Since the technology may be new to both teacher and the students, it will be particularly important to know your learners as you utilize a technology that may be new to both you and the students. Shaeffer and Farr (1993) recommend that instructors take time to get to know their students, to establish a good learning environment, and allow each student an opportunity to experience the technology. Martin (1994) suggests striving to incorporate as much interaction as possible with students. Martin also identifies motivation as a key factor in successful distance learning experiences for students.

Learner Characteristics Suggestions

1. Consider different strategies that you can utilize to become acquainted with the students at various sites. It is extremely valuable to visit each site at some point in the term so that you can have a chance to personally meet each student.
2. Spend some time acquainting the students with the technology. This should be done during the first class meeting. Each student should be encouraged to speak over the system (i.e., introducing themselves or each other) to help them become comfortable with the technology as soon as possible.
3. Some of your students may remain reluctant to ask questions over the system. Provide opportunities for students to ask questions during times that all students are not observing the system. Allow time at the end of the class when other students have left to respond to student questions.
4. It may be helpful to develop a means of analyzing your learners in regard to their learning preferences and/or their attitudes toward the technologies being used in the course.
5. Consider additional strategies that might personalize or humanize the technology for students at remote sites. Build in time for telephone conferencing during the week to provide for additional interaction with students located at the various sites.

Goals and Objectives

Haughey (1992) suggests beginning the course with an outline that details the instructional design; specifically, the sequence of topics and instructional strategies for each topic. Miller, McKenna, and Ramsey (1993) agree that print versions of the course should be included as part of "multiple-medium coverage of course content" (p. 55). In addition, Martin (1994) recommends that distance learning courses should include a student guide and an instructor guide.

Goals and Objectives Suggestions

1. Remember that students require presentation of information in a variety of modalities. It is important to provide written handouts as well as verbal instructions.
2. Goals and objectives for the course should be clearly defined. When designing the course, determine if any of the course goals and objectives should be revised.

Instructional Strategies

Shaeffer and Farr (1993) suggest that successful experiences with distance education result from "faculty development, class-by-class feedback forms, midterm feedback sessions, and end-of-course evaluation by both students and faculty" (p. 79). They also report that students value the interaction of groups at each of the sites and recommend that site group work be incorporated into each of the distance education courses. Martin (1994) suggests the use of advance organizers throughout the instruction to help students know what to expect.

Instructional Strategies Suggestions

1. Remember that the distance learning environment is different. Consider all of the sites in your planning and keep in mind how the students at the remote sites might react to various instructional strategies.
2. Experiment with various instructional techniques over the system. Most instructional strategies are congruent with the distance learning environment. Some of the models of teaching that might provide alternatives for the distance learning classroom include: lecture, demonstration, panel discussions, class discussions, peer teaching, cooperative learning, group investigation, role playing, simulation, guest presentations, case studies, modeling, advance organizers, and debates

Selecting Media and Methods

Using appropriate methods of delivering information is essential to effective communication of course content.

Martin (1994) indicates that distance learning instructors who use a variety of media over a system will have more success. Shaeffer and Farr (1993) recommend providing visual representations of concepts.

Media and Methods Suggestions

1. The media format selected should match the method of instruction.
2. Communication of course content must be clear and specific.
3. If you are utilizing commercially produced media, preview it in its entirety prior to using it.
4. When using commercially produced fixed-paced media (audiotapes, videotapes, filmstrips) consider whether the presentation should be used in its entirety or in segments.
5. Incorporate several means of communicating important information to your students. Varying the means of communication also helps to engage the learners.
6. Include modules to provide students with a class-by-class description of course goals and objectives. Weekly class modules should also contain references for students who need additional information on a given topic.
7. Provide visual representations to guide students through concepts of course topics. Visual representations that can be utilized in the distance learning classroom include still graphic representations, textual information, audio, video, and computer generated displays.

Evaluation

The instructor should design evaluation questions based on those concerns that would be relevant to the course or the specific instruction (Shaeffer and Farr, 1993). For example, the students might be asked to respond to a question concerning their understanding of course content for that class session or respond to a question concerning their attitude toward the technology up to that point. Martin (1994) concludes that when using a distance learning system, "feedback and reinforcement are essential to successful learning" (p. 53).

Evaluation Suggestions

1. Plan for the type and amount of feedback that you want from the students.
2. Formative evaluations can be accomplished on a class-by-class basis by asking students to respond to two or three questions.
3. Consider evaluating different aspects of your course (i.e., the technical aspects vs the instructional components).

Acknowledgement

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A Model for Technology Infusion in Higher Education

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The School of Education at the University of South Dakota (USD) recently completed and successfully passed all 18 standards as part of its review by the National Council for Accreditation of Teacher Education (NCATE). The USD knowledge base theme is Reflective Decision-Making because graduates are taught a method of analyzing, synthesizing, and applying their knowledge to local, national, and global educational issues. (See Figure 1) An emerging issue of prominence for improving that knowledge base is the role of technology in the preparation of educators.

The USD School of Education has created a model for technology infusion as it reviews its curriculum and prepares for the next NCATE review. The model focuses on empowering teachers, including faculty from higher education and cooperating public schools, as well as pre-service teachers, to become better consumers and advocates of technology in the teacher education program for the improvement of teaching and learning. The matrix structure used to design, plan, and implement that model is identified as the Center for Interactive Technology in Education and Corporations, otherwise known as InTEC.

One of the critical issues facing educational leaders today is how to restructure the nation's public school system to better meet the needs of students, now and in the future. The traditional focus of schools has been on the acquisition of knowledge and low-level skills through the transfer of information from teacher to student, but that approach is becoming less acceptable to learners (and to their potential employers). The restructured model now emphasizes the learner's engagement in the educational process where terms like collaboration, problem solving, interactivity, and reflection become the norm, rather than the exception. The USD Model for Teaching and Learning (Figure 2) illustrates the reflective or independent nature of many variables which affect learning outcomes in a teaching or training situation, as well as the continuing influence of many variables which educators need to consider in making effective professional decisions in an ever-changing information society (University of South Dakota, 1993) Technology is a means to create an environment that shifts to active engagement in the learning process through risk-taking, collaborative learning, and problem solving by the learners. Technology can have many definitions and forms, but one of the most common and visible applications of technology is the computer. According to Dell and Disdier (1994), computers have not had as great an impact on the educational process as anticipated because teachers and other educational leaders have not been adequately trained to apply computer technology to class work, the curriculum, and numerous school programs. This is becoming increasingly apparent in relationship to higher education faculty.

As part of its accreditation efforts, NCATE has recognized the need for the use of technology in education as a fundamental part of the teaching, learning, assessment, evaluation, and productivity process. Technology competencies should focus on functional skills and on the people who must make decisions on how to use them, as

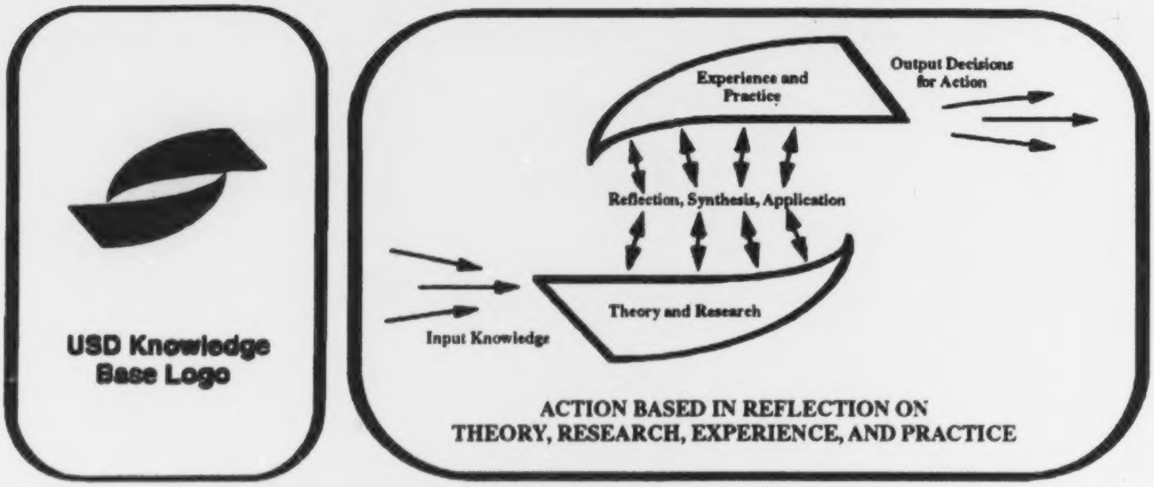
USD Knowledge Base Logo
Experience and Practice
Output Decisions for Action
Reflection, Synthesis, Application
Theory and Research
Input Knowledge
ACTION BASED IN REFLECTION ON THEORY, RESEARCH, EXPERIENCE, AND PRACTICE

Figure 1. Reflective Decision-Making Logo and Explanation.

well as provide opportunities for advanced applications. Technology standards for preparation of leaders in education must include (1) how to use technology, (2) application of instructional principles, research, and appropriate assessment practices, (3) demonstration of knowledge in the use of computers for problem solving, data collection, information management, communications, presentations, and decision-making, (4) design and development of student learning activities that integrate computing and technology for a variety of student grouping strategies and diverse student populations, (5) demonstration of knowledge in the use of multimedia, hypermedia, and telecommunications to support instruction, and (6) demonstration of knowledge relative to equity, ethical, legal, and human issues of computing and technology use as they relate to society (Nason, 1994).

One particular aspect of importance will be the standards and indicators that direct the use of technology in teacher preparation programs. Following are two examples from the Refined Accreditation Standards Adopted by the NCATE Boards (National Council for Accreditation of Teacher Education, 1994) which emphasize how teachers and higher education faculty will be affected in future accreditation visits:

Standard III.A.: Faculty Qualifications (Initial and Advanced).

> Indicator 40; Professional education faculty have completed formal advanced study and have demonstrated competence through scholarly activities in each field of specialization that they teach....Higher education faculty are knowledgeable about current practice related to the use of computers and technology and integrate them in their teaching and scholarship.

Standard IV.B.: Resources for Teaching and Scholarship (Initial and Advanced).

> Indicator 63; Faculty and candidates have training in and access to education-related electronic information, video resources, computer hardware, software, related technologies, and other similar sources.

But in order to be successful, it is also recognized by the profession that educational leaders need training, support, and time for reflection to integrate technology into the school programs. This transformation of the educational system in our society will not occur unless technology becomes an effectively used instructional and management tool (Robertson, 1994). The ultimate goal, therefore, is to prepare educational leaders who can determine the match between the needs of the students and the technology options, and then to link the use of technology with effective teaching and learning practices.

Part of the problem occurs in colleges and universities which continue to produce educational leaders who do not have the skills to enhance curriculum and instruction with computers and other technologies (Dell & Disdier, 1994). Higher education faculty appear aware of the problem but they may also need help in making changes in their curricula to meet the emerging demands of technology-integration into the existing framework. Educators of teachers and other professionals (administrators, counselors, curriculum directors, librarians and other resource people, etc.) also need access to the technology and must be able to model the use of technology. These are major barriers to accomplishing the transformation because they require time, money, planning, and expertise.

The School of Education at the University of South Dakota has taken the opportunity to address these concerns through a research and development initiative in technology. Through the establishment of the Center called InTEC (Interactive Technology in Education and Corporations), faculty are provided an opportunity for development of their technology skills through a release program with time-sharing duties. Those duties include, but are not limited to, (1) faculty development and training, (2) networking, (3) liaison to the Professional Development Center program to work with public school teachers, students, and administrators, (4) management of projects with other School of Education faculty, (5) supervision of the computer lab(s) and the demonstration classroom(s), (6) production support for research and development initiatives, (7) grant writing for external funds, and (8) other developments on an "as needed" basis.

The model also allows faculty assigned to InTEC to meet Divisional goals of integrating technology into the curriculum, as well as their professional and personal goals of attaining competence in the use of technology. InTEC members serve as mentors for their colleagues by conducting seminars on technology topics and by training other faculty in the use of various technologies in their classes. The underlying strand in this matrix is the use of technology for better preparing the teachers of the future and for their personal promotion in terms of excellence in teaching, research, and service.

Great change will occur in education through technology, but it will require faculty and students to rethink some of the fundamental ideas about what it means to teach and learn. Faculty need to realize that technology, especially multimedia, provides a medium for promoting effective use of teaching strategies, styles, and reflective practice in the classroom and in the field. As a pedagogical tool, technology can be used to promote equity in education because human potential can be better realized as people communicate more effectively through words, sounds, and images in a "show me" rather than just "tell me" approach. Terms like active learning, critical thinking, interactivity, multimedia, telecommunications, and collaboration will become increasingly important as technology becomes more integrated and accepted 1) across grades and into the

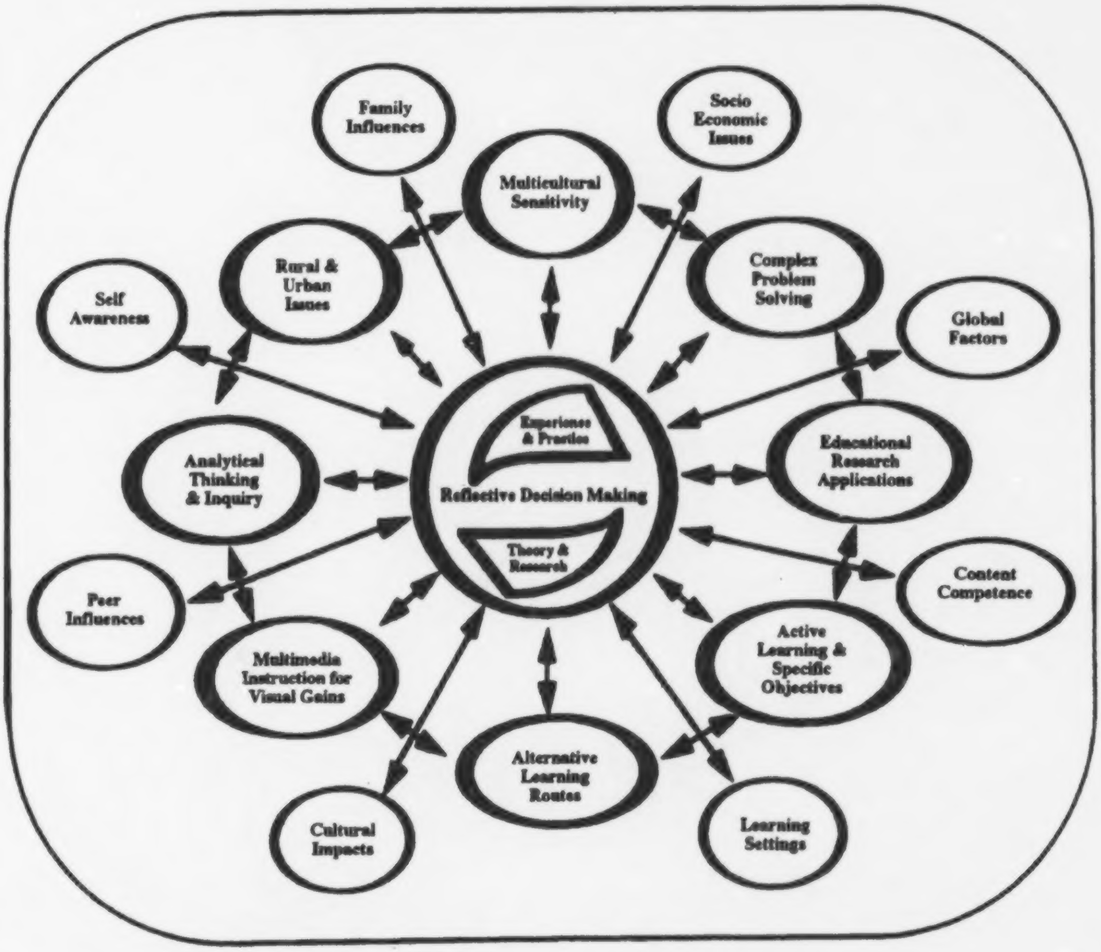
Family Influences
Socio Economic Issues
Multicultural Sensitivity
Rural & Urban Issues
Complex Problem Solving
Self Awareness
Global Factors
Experience & Practice
Analytical Thinking & Inquiry
Reflective Decision Making
Educational Research Applications
Theory & Research
Peer Influences
Content Competence
Active Learning & Specific Objectives
Multimedia Instruction for Visual Gains
Alternative Learning Routes
Cultural Impacts
Learning Settings

Figure 2. USD Model for Teaching and Learning.

curricula, 2) as educational leaders put more demands on the system, and 3) as society places more emphasis on the need for teacher-educators to be on the "cutting edge" of technology in order to better prepare the work force of tomorrow.

Tremendous progress has been made these past three years as InTEC has assumed an increasing leadership role in directing needed change in understanding the use of technology. Such changes have affected the entire School of Education and have included decisions relative to staffing of InTEC with faculty appointments, offering required courses at the undergraduate and graduate levels in all Divisions, and development of a program of study option in educational technology. Through the use and expansion of this model, the School of Education at the University of South Dakota has the opportunity to address these concerns in technology, to become recognized for its efforts in the profession, and to open windows to the world of information for its students and its faculty.

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Collegial Consultants: Employing an Entrepreneurial Model for Technological Literacy

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The Center for Instructional Technology and Innovation (CITI) was incorporated as part of the University of Wisconsin - Eau Claire's (UW-EC) efforts to integrate more uses of technology into undergraduate and graduate curriculum across the campus. UW-EC is a medium sized (student population approximately 10,000) liberal arts, four year university, and one of the largest of the twelve University of Wisconsin System campuses. The CITI's goals are simply to: 1) enable the study of what is possible, 2) demonstrate various technologies, 3) practice what has been learned, 4) receive coaching and mentoring, and 5) experiment beyond basic applications. Conceived as a training center for increasing information and technological literacy and funded by Title III federal dollars, the CITI opened in February 1994 and continues to evolve to meet current and future needs of faculty and teaching staff at UW-EC, and to support parallel initiatives. This paper describes the evolution of the CITI, its mission, vision, philosophy, and the entrepreneurial professional development model for technological literacy, called the "Collegial Consultant Model," which is being used to provide increased technological literacy for UW-EC's faculty and teaching staff.

History

The University of Wisconsin at Eau Claire successfully won a Title III grant in 1990 and a Faculty Support Center was outlined in that grant. Three committees were established to begin the planning necessary to implement the Center. These committees were Planning and Policies, Curriculum, and Facilities and Equipment.

After surveying faculty, the Curriculum Committee set goals for proposed workshops, demonstrations and other types of instruction incorporating new kinds of pedagogy and collaborations. Only after the curriculum was in place did the Facilities and Equipment Committee begin to select the kinds of hardware and software that would support the envisioned curriculum that would take place in the CITI and other instructional technology locations on campus.

The Planning and Policies Committee, however, was most closely related to defining what the CITI would become, and the membership was broadly represented with respect to faculty, academic staff, classified staff, teachers, and administrators. This Committee defined the Vision, the Mission, the Philosophy, and the role of the CITI Coordinator.

Vision

The vision of the CITI was defined in five areas.

1. Study: Resources to enable the study of what is possible. That study will increase awareness and understanding of what technologies are available and their effective use and integration into teaching and learning. The study process might include workshops and seminars conducted by CITI staff or other skilled individuals from within or outside the university. In addition, opportunities for the development of strategies for the thoughtful incorporation of information technology into the curriculum will be provided. This might include focus groups of faculty who are developing a vision of a particular application of technology.

2. Demonstrations: Demonstration of various technologies and their integration into teaching and learning. Opportunities to observe applications of technology should take place across the campus and beyond. The CITI is a location where University personnel can observe center staff and colleagues using technology in a variety of ways. Vendors and others will be asked to contribute products to allow University personnel to visualize possibilities for applications of technology.
3. Practice: Practice of what has been learned. The CITI should function as a supportive environment, where, under safe conditions, skills can be developed and confidence increased while having access to expert assistance. Practice can also occur elsewhere as the technology becomes increasingly available.
4. Support: Access to various types of needed support. Coaching and mentoring should be available for those who want to make use of technology in teaching and learning. Assistance should be available for those interested in developing technology applications. Professional assistance and coaching may be provided by CITI staff, colleagues, or other skilled individuals from outside the University.
5. Exploration and Experimentation: A laboratory where faculty can safely explore and experiment. The CITI should be a facility where opportunities to move beyond basic applications are possible. Options that may or may not be generally available at this university should be explored. As the technology, connectivity and applications become more widely available, this too will spread across the campus.

Mission

The CITI has three purposes. The fundamental purpose is to fulfill the Title III Training Center grant goal: to raise the information and technology literacy of faculty and teaching academic staff and assist them in integrating technology into curricula. The primary focus of the activities is staff development leading to literacy in the areas of computing, library, media, and networks.

A second purpose of the CITI is to provide assistance to faculty and teaching academic staff in applying technology related to research, advising, and service. Assistance will also be provided to University support staff.

A third purpose of the CITI is to serve as a catalyst for technology integration. Due to the evolving nature of "current" technology the CITI will facilitate the increasing and thoughtful application of information technology across the curriculum. This is an integral part of both the CITI's mission and the University's Network for Excellence in Teaching (NET).

As time and resources dictate, other uses of the CITI will be permitted with priority given to instructional, advising, research, and service endeavors.

Philosophy

The CITI is based on the belief that it is not just a physical space. It is a staff development program, with people, activities, facilities and resources to facilitate achievement of information technology staff development goals. It is also based on the belief that:

1. Educated citizens will depend upon technology to perform their jobs and to continue their learning.
2. Instruction can be improved with the use of technology.
3. Instructional and support staff will embrace the use of technology if it substantially aids them in their professional responsibilities.
4. The CITI should foster awareness and proficiency in using information technology to support teaching and research.
5. Technology enhances learning only when it is appropriately used.
6. Instructional and support staff should be provided a forum for discussions about the impact of technology on pedagogy and content.
7. Adaptability and flexibility of the CITI's program is essential to meeting ongoing information and technology staff development needs.
8. The integration of information with other teaching/learning approaches can lead to the development of new teaching/learning paradigms.

CITI Coordinator

To coordinate this mission, a CITI coordinator was essential. The Planning and Policies Committee was responsible for the position description of this individual. The Coordinator will report to the Assistant Chancellor for Information and Technology Management (ITM). A subcommittee of the Faculty Advisory Committee for Information Technology (FACIT) will act as an advisory committee for activities of the CITI. Formal and informal contacts with ITM directors and staffs will regularly occur. The CITI Coordinator will meet regularly with faculty, focus groups, and academic departments to assess needs and develop programming. The person in this position will also develop a collaborative relationship with the Network for Excellence in Teaching Council (NET) and the Office of Graduate Studies and University Research to further enhance the staff development program planning for the CITI.

The responsibilities of the CITI coordinator are divided as follows:

- 60% Professional development planning and programming
  - Outreach and leadership with faculty and staff including program needs, assessment, development and evaluation
  - Coordination with FACIT
  - Coordination with Graduate Studies and University Research and faculty for grantsmanship to sustain program
- 40% Coordinate Center for Instructional Technology and Innovation
  - Day-to-day operations, scheduling
  - Center evaluation & assessment

The qualifications for this position include: a demonstrated interest in diverse information and technology issues and activities, demonstrated management, organization, communications, people and team skills, knowledge of adult learning principles and curriculum development. This position will be filled by a member of the faculty or teaching academic staff.

Infrastructure

A place like the Center for Instructional Technology and Innovation does not occur in and of itself. Several activities have occurred at the UW-EC campus that support and assist in setting an environment in which an initiative such as the CITI can be successful. Some of these are listed below:

Faculty Support and Professional Development Initiatives:
- Title III
- Network for Excellence in Teaching
- Redefinition of the Baccalaureate Degree
- Computer General Access

Initiatives Involving Internal and External Funding:
- Lab Modernization
- Information Technology Resource Center Project
- Classroom Modernization
- Instructional Technology Grant

Each of the these initiatives involve either support to faculty and teaching staff with regard to professional development activities and technology availability and/or with funding. Therefore, the Center for Instructional Technology and Innovation finds itself situated in an infrastructure that supports change, innovation and rewards for increased use of technology and technological literacy.

Collegial Consultant Model

"Collegial Consultants" are teaching faculty and/or staff who have been selected to receive $1,000 support through Title III Faculty Stipend dollars. They serve as conduits to departments and units from the CITI to faculty needs. Each collegial consultant has composed a single-page proposal which outlines an idea where technology could be integrated into a facet of instruction whereby undergraduates and/or graduates would benefit from the proposed technological infusion. These proposals are reviewed by the thirteen members of the NET Council. The guidelines for evaluation are simple and threefold: 1) the proposal's impact on students, 2) the proposal's impact on the individual's professional and technological development, and 3) the benefit of the proposal to the University (e.g., plans for on-campus seminars, presentations, dissemination of results).

Fifty-four proposals were received from faculty and teaching staff to participate in the Collegial Consultant Model during the pilot program scheduled for the summer of 1994. Sixteen of these proposals were chosen as good examples of using technology in undergraduate/graduate education. The authors of these proposals were awarded $1,000 stipends and participated through the summer in teleconferences, demonstrations, workshops, literature reviews, visits to other campuses, and in activities which served as professional development for continuation and finalization of their proposed projects. They also served as CITI Monitors, volunteers "sitting" in the CITI for an hour or more per week, sharing whatever expertise they have with whoever needed it. During the spring and summer of 1994, the CITI Monitors clocked in a total of 835 hours of volunteered time in the CITI and recorded a total of 308 drop-in visitors. Data of this nature is now being compiled for the fall 1994 semester where seventeen of the twenty eight proposals were funded.

Collegial Consultants serve for one hour weekly as CITI Monitors and participate in the CITI-fair and Technology of the Week initiatives. Through working on and implementing their projects, Collegial Consultants become expert learners and assistants to their teaching colleagues with regard to promoting technological literacy and learning more about what is possible. (See Figure 1)

CITI Monitors

The CITI Monitor initiative has come to be accepted as a time to "play in the CITI" rather than a time to be expected to help others. Yet, drop-in colleagues ask questions of the CITI Monitors, some of which cannot be answered by the "Monitor on duty." In these cases, the Monitor and the inquirer learn together. Thus, the CITI Monitor initiative is a learning model in and of itself. Monitors schedule their time in the CITI to work on their projects, to explore and study technological possibilities, and to help each other as they work on similar technological problems (e.g., the development of CD-ROM courseware).

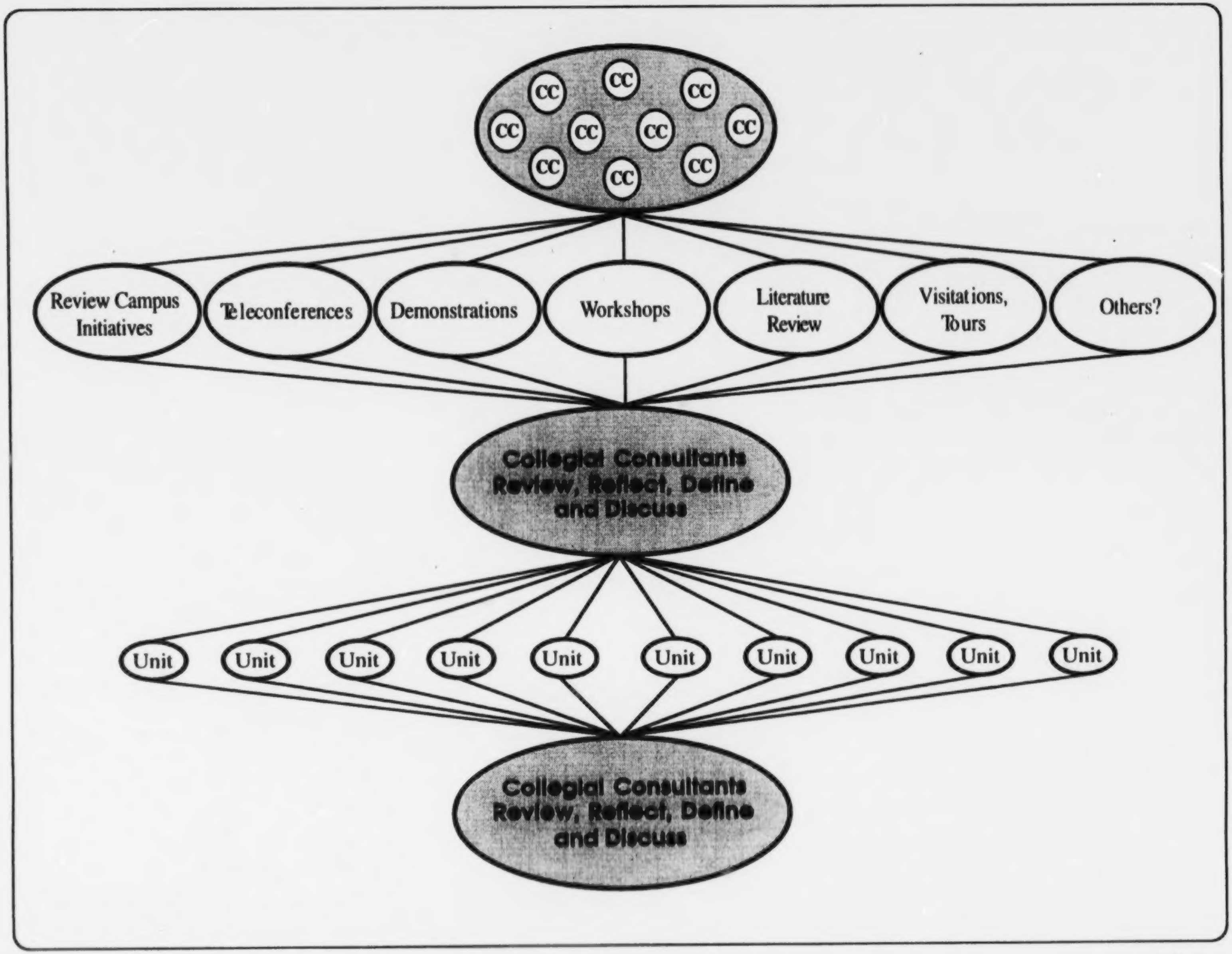
CITI Gopher

The Coordinator for the CITI has created a CITI Gopher where information regarding the CITI's mission, vision, and philosophy are described. Additionally, the CITI Coordinator's position description is posted there as well as all successfully funded faculty proposals from the summer and fall of 1994. For ideas with regard to what faculty are working as they integrate technology into instruction, the CITI Gopher is an excellent source of information. To gain access to the gopher:

UW-EC Home Gopher (gopher.uwec.edu)
select Computing and Technology Services
select Resources for Instruction
select Center for Instructional Technology and Innovation (CITI).

CITI-Fair

The NET Council provides multiple opportunities for professional development activities that focus on excellence in undergraduate teaching. The CITI, in collaboration with the NET Council, provides several programs, usually occurring during the lunch hour where participants are invited to bring their lunches, and where opportunities are provided to use the technology in undergraduate educational applications. Two times each semester the Collegial Consultants gather to report on their projects in the form of updates or progress reports. In these "tellings," the Collegial Consultants share their joys and frustrations about their projects, what software and hardware applications they have used, and commentary regarding training time and the like. As each of their accepted proposals is posted on the CITI Gopher, participants have an opportunity to ask specific individuals who are participating in the Collegial Consultant


CC
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Review Campus Initiatives
Teleconferences
Demonstrations
Workshops
Literature Review
Visitations, Tours
Others?
Collegial Consultants Review, Reflect, Define and Discuss
Unit
Unit
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Collegial Consultants Review, Reflect, Define and Discuss

Figure 1. The Collegial Consultant Model for Professional Development in Technological Literacy

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Model more about their particular projects. The conversations have been useful and effective in creating campus wide sharing, and creating technology "experts" among faculty and staff who might not otherwise be in contact.

Technology of the Week

Collegial Consultants also participate in the Technology of the Week initiative, sessions meant to spread the word about technological options and information available on campus. These sessions are nearly always about an hour in length and may be presented in a workshop, demonstration, hands-on or "brown bag" (over lunch) format. Each Collegial Consultant is asked to present at least one Technology of the Week session as an obligation of his/her funding. Other Technology of the Week sessions are presented by instructional staff from the Library, Computer and Networking Services, the Media Development Center, and other units. Additionally, some faculty and teaching staff have volunteered to present Technology of the Week sessions either alone or in collaboration with a colleague. An example is the co-presentation of alternative on-line services to access the Internet (e.g., America Online, Prodigy, CompuServe) which was presented by several persons from the faculty and staff ranks who had personal subscriptions to these various services. Other examples include Collegial Consultant project updates, software and hardware demonstrations associated with the various projects that are guiding and directing the kinds of software and hardware purchased and supported not only in the CITI, but in the home departments and units as well.

Curriculum

Workshops offered through the CITI during the fall of 1994 include the broad categories of communication (e.g., file transfer), databases (e.g., FoxPro), creating and enhancing documents, graphics and scanning (e.g., using Deskscan, Adobe Photoshop, OmniPage, etc.), telecommunications (e.g., Gopher, Mosaic, Netscape, FTP commands, and America Online, etc.), Macintosh Basics, Macintosh Special Topics, VAX, Windows Basics, and Windows Special Topics. In total, workshops numbered seventy-one with three hundred and thirty-three attendees. Additionally, a series of special workshops by Collegial Consultants and other interested faculty and staff numbered twenty with one hundred forty-four attendees. These offerings continue to change with the needs of the faculty and staff and with the purchase and support of various software packages. These also change in accordance with the faculty and staff who come to the Model as participants with different skills, expertise, and developing interests. New collaborations which have been created by the Model enhance the instructional and training aspects so that collaborative instruction is becoming more and more the norm. Library staff, for example, work with computing-support staff members and with faculty, to plan presentations and to share what they are learning. For example, eighteen new workshops were added to the fall 1994 curriculum as a result of these collaborations.

Conclusion

UW-EC's Center for Instructional Technology and Innovation is an example of professional development in technological literacy which focuses on an infrastructure that involves the entire campus rather than departmental or single unit initiatives. This whole campus focus allows for management of limited resources and a plan of support which excludes redundancy and encourages collegiality across the campus. Instead of creating experts in particular schools or units, campus community members are becoming experts that assist one another across units and departments. Conversations occur across disciplinary lines and therefore cross-disciplinary projects are being fomented. Additionally, staff vs. faculty lines are being crossed and broken-down. We have long passed the time when a single individual can be an expert on all technologies. The entrepreneurial professional development model being used at UW-EC in and out of the CITI encourages the development of faculty and staff working together on common problems. The conversations created by the Model become ways to participate in needs analyses and provision of resources and support appropriate to the efforts and interests of those involved, and the process nature of the Model responds well to the ever-changing world of technology.

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The Next Generation: Going Beyond the Models

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Although the pace may vary from organization to organization, change itself is inevitable. Education is constantly thrust into change because of societal demands and out of necessity (Ritchie & Wiburg, 94). Change is not easy, especially for professors who were not educated in the Information Age. Professors are important role models for teachers and school staffs whether they are in school partnerships or in teacher preparation. As facilitators, they stimulate the participants to work with new reform efforts. They demonstrate problem-solving and the use of hands-on activities. As change agents, they possess information that will assist others in making knowledgeable decisions. Being a visionary assists others in looking for possibilities and changes for the future. In order to fulfill these roles in contemporary school settings, many professors will need staff development to learn and use the latest methods and technology (Mc Kenzie & Mims, 94; Staudt, 94).

Many faculty members who are just beginning to feel comfortable with word processors are often confused with advanced technology and terms such as CD-ROM, e-mail, networking, super highway, and the biggest headache of all—distance learning. If education professors are to continue the roles expected of them, then they must learn to use the technology so important to the next generation.

Description of the Program

Staff development programs are usual for instruction of faculty and staff. Most models of inservice consist of describing the skill, lecturing, and if possible, providing hands-on experience. However, without feedback and advanced training that builds on past experiences, the old adage of "if you don't use it, you loose it" retains its meaning.

West Georgia College has gone beyond the usual staff development programs. Faculty are trained and retrained with the newest equipment; they are encouraged to use the equipment in their classes using collaborative teaching methods. Needs assessments are done twice a year to determine faculty skill levels, future needs, and current usage. Among the ongoing technology sessions are discussions that focus on new directions such as how to plan lessons for distance learning and working with two classes at one time. Updates are given on software as well as general "how to" sessions for new faculty and those who haven't used a particular program.

The West Georgia College School of Education is taking the lead in technology training for the whole campus, and it is not unusual for professors, administrators and support staff in all fields to attend any or all of the sessions. During the past two and one half years, 44 inservice presentations have been offered to over 375 participants from the college and community. The emphasis of the sessions is keeping participants up to date on the latest technological developments and their applications in the classroom.

Methodology

In planning for the 1994-95 staff development programs in technology, feedback was obtained from three predominant sources: past participants in the technology training programs, School of Education faculty, and selected practitioners in the field. Both formal and informal data were collected from survey questionnaires. Past participants in the training series provided evaluative information on the impact of the sessions by informally talking to the training coordinator and selected presenters at the end of the sessions; other participants sent written suggestions for program improvements to the coordinator.

To assist in planning the upcoming year's technology program, all 72 School of Education faculty members were given a needs assessment questionnaire at the end of the 1994 school year. They were asked to respond to four open-ended questions:

1. What are your current technology training needs?
2. What days and times are you available for technology workshops in the fall?
3. Do you have any suggestions for technology speakers?
4. Do you have any suggestions for program improvements from last year?

In addition, selected graduate students in the School of Education enrolled in administration and media classes were asked to complete a questionnaire. Using a 5 point Likert scale, the respondents were instructed to circle a number that represented the degree of training that was needed by practitioners they had recently observed. A 5 indicated extensive training was needed while a 1 indicated no training was needed. The respondents were also asked to reply to three open-ended questions:

1. What method of training do you feel is the most effective for teachers and administrators (i.e., conferences, in-services)?
2. What is the ideal length of a technology training session?
3. What days and times do you view as the most appropriate for technology training sessions?

Analysis

The responses to the four open-ended questions given to School of Education faculty and staff were typed up and then a content analysis was done by the two investigators. The individual statements from each question were extracted by each rater and compared to determine the degree of agreement. Once the raters agreed upon a final response, the statements were quantified by tallying the number of times each statement was made. The resultant statements were rank ordered from the most frequently occurring statement to the least.

Two analysis procedures were used to analyze the technology findings of the practitioners. Mean scores were computed for each of the 14 listed types of technology and rank ordered from the highest to lowest. A content analysis of the three open-ended questions was once again determined by independent raters and they tallied the number of times each statement was made. The final statements were rank ordered by their frequency of occurrence.

Results

Fifty (69%) of the 72 faculty and staff surveys were returned. Respondents reported that they were the most interested in technology training dealing with computers and the new and emerging types of technology in the field, especially word processing and integrated packages. Thirteen technology training areas were identified. Computer utilization skills ranked first followed by multimedia applications in the classroom. The days and times personnel identified as the most appropriate for training sessions were Friday afternoon (15), Friday morning (10), and Thursday afternoon (8). The rest of the responses were scattered throughout the week depending on teaching schedules.

Table 1
Results of Technology Training Needs Assessment of School of Education Faculty and Staff - In Rank Order

What are your technology training needs?

Rank	Technology	N
1	Computer Utilization (WordPerfect, PageMaker, ClarisWorks, Microsoft Works, Excel, Scanner, and paint & draw programs)	18
2	Multimedia (HyperCard, Linkway)	16
3	E-mail\Internet	15
4	PowerPoint Presentation Graphics	14
5	CD-ROM	14
6	Distance Learning	14
7	PageMaker	12
8	Laser Discs	11
9	Integrating Technology into the Curriculum	10
10	Instructional Video	10
11	Photography (35mm & digital camera)	8
12	JMP Statistical Program	7
13	Scantron	4

When asked for recommended technology presenters only four individuals were mentioned, three of whom has been past presenters in the program. Suggestions for workshop improvements produced only five general recommendations. The most frequently mentioned suggestion was to provide more opportunities for participants to interact with the technology after the session or at later dates (see tables 1 & 2).

Table 2.
Workshop Improvements

Do you have any suggestions for workshop improvements from last year?

Rank	Response	N
1	Provide more opportunities for participants to play with the technology after the session or at later dates	25
2	Provide training sessions at other days and times since some faculty are scheduled to	

	teach Friday mornings	20
3	Increase the length of the training sessions	14
4	Continue beginning level training sessions with intermediate and advanced level sessions	11
5	Videotape the training sessions so that those who cannot attend can view the video at a later date	8

Eighty six of the 100 surveys distributed to randomly selected administrators and media specialists were returned. Practitioners identified multimedia, computers, and CD-ROM as three areas where technology training was needed the most. The method of training that was identified as most effective for teachers and administrators in the schools was the inservice. The ideal length of time for training sessions was 2 to 4 hours. Thursday was the day the majority (48%) of the respondents felt was most appropriate for training sessions and 8 a.m. until noon was the most frequently mentioned time (see Tables 3-6).

Table 3
Technology Training Needs of Practitioners in the Field - In Rank Order

Based on your recent observations of teachers, please circle a number from 1 (no training) to 5 (extensive training) that indicates the degree of technology training you believe is needed in the 14 listed types of technology.

Rank	Technology	Mean	s.d.
1	Multimedia	4.28	.90
2	Computers	4.13	.94
3	CD-ROM	4.00	1.04
4	E-mail	3.95	1.12
5	Telecommunications (Distance Learning)	3.92	1.29
6	LCD Panel	3.70	1.37
7	Videodisc	3.47	1.29
8	Video	3.36	0.94
9	Fax	3.34	1.13
10	Photography Camera	3.02	1.22
11	Slide Projector	2.31	1.01
12	Filmstrip Projector	2.05	1.18
13	Overhead Projector	2.01	1.15
14	Opaque Projector	1.97	1.03

Table 4
Most Effective Technology Training

What method of technology training do you feel is the most effective for teachers and administrators?

Rank	Response	N	%
1	In-services	72	83.7
2	Hands-on instruction	30	34.9
3	Conferences	7	8.1
4	Workshops	5	5.8
5	Small group instruction	4	4.7
6	One to one instruction	4	4.7
7	Computer training	3	3.5
8	CD-ROM training	2	2.3

*Note: only responses with 2 or more citations are listed.

Table 5
Training Time

What is the ideal length of time of a technology training session?

Rank	Response	N	%
1	2 to 4 hours	32	37.2
2	1/2 day	20	23.3
3	All day	14	16.3
4	1 to 2 hours	13	15.1
5	30 to 60 minutes	11	12.8
6	Variable	9	10.5
7	3 days	4	4.7
8	1 week	2	2.3
9	2 to 4 weeks	2	2.3

Formative and summative information obtained from the three technology assessment techniques were used to revise and restructure the current technology training program. As a result, the fall sessions were delivered Friday afternoons from 1:00 - 3:00 p.m. and had three times the enrollment of the past sessions. The contents of training sessions this past fall, dates, and number of participants are shown in Table 6. The sessions drawing the greatest enrollments were e-mail/ Internet, PageMaker, and Introduction to WordPerfect.

Table 6
Fall Technology Training Session 94-95

Session	Date	# of Participants
•Introduction to WordPerfect on the Mac	Sept.	13
•Power Point Presentation Graphics	Oct.	9
•E-mail/ Internet	Oct.	34
•PageMaker I	Oct.	15
•Distance Education	Nov.	9
•Integrating Technology into the Curriculum Using CD-ROM and Videodiscs	Nov.	15
Total Participants		95

To evaluate the overall impact and degree of success of the selected training sessions, program assessment instruments were administered and collected at the end of each session. Participants were asked to apply a 5-point Likert scale and evaluate five selected variables concerning the instructor's knowledge, presentation style and helpfulness as well as the quality of the program content and relevance of the session. Respondents were also asked to complete three open-ended questions: 1) What information in the training session was most helpful to you?, 2) What improvements would you recommend?, and 3) List specific ideas for future training programs.

An analysis of the program evaluation sheets demonstrated that participants were extremely satisfied with the technology information that was presented and the teaching qualities demonstrated by the selected presenters. Mean scores for the variables ranged from 4.52 to 4.82 on a 5-point scale. The highest rated factor dealt with the instructor's knowledge of the technology. The responses to the open ended questions, however, were minimal. The investigators feel that due to the busy schedules of those attending the sessions, participants did not take the time to completely fill out the assessment forms (see table 7).

Table 7
Fall Quarter Program Evaluation Findings

Factor	Mean
1. Instructor's knowledge of the technology	4.82
2. Instructor's overall presentation of the technology	4.72
3. Instructor's helpfulness and courtesy during the training session	4.82
4. The quality of the program content	4.64
5. The relevance of the session to your work	4.52

Winter quarter technology sessions are currently being planned based on observational data as well as needs assessment data. Sessions will be delivered at the beginning and intermediate levels in WordPerfect and PageMaker, computer scanning, multimedia applications in the classroom, and e-mail/Internet on both the Macintosh and IBM platforms.

Future Directions

New directions for the future technology training programs are being considered. The program will continue to focus on the new and emerging types of technology in the schools and the ever changing training needs of professionals.

Increased enrollment in the training programs requires additional funding to purchase additional hardware and software. This would enable more hands-on learning opportunities for participants on a greater variety of technology, especially multimedia applications in the classroom, integrated packages, and distance education.

Due to increased use of distance education in Georgia this past year, the investigators are also exploring the possibility of delivering technology training to interested participants in the region through use of our GSAMS (Georgia Statewide Academic and Medical System) equipment. At the present time approximately 200 different sites in the state have been established that could easily deliver technological training to multiple locations. Technology training could easily be delivered to multiple sites.

Summary

Faculty who were unsure of using new technology, who used only typewriters in the past, and who believed that snail mail was the surest way to communicate are now using e-mail with ease. They communicate with other faculty and more important, with students and find e-mail to be cost-effective and useful because they interact with students on a one-to-one basis. The ability to view teachers in their classrooms allows for a more spontaneous discussion with student teachers and feedback on effective practices is immediate. Professors appear to be more at ease with technology and waiting lists now exist for many of the training sessions. Students are introduced to technology hardware and software early in their teacher education programs, and they, in turn, are no longer intimidated when teaching children of the next generation.

Faculty understand the need and importance of teaching students to learn to cope with the next century and global society. But until they can participate at their own comfort levels and use the technology, the students they teach may fall behind in the 21st Century.

Acknowledgement

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Faculty Technology Development Model

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This paper will discuss the development of an innovative project that was conducted to promote the collaborative development of technology skills (i.e. use of computers, telecommunications, desktop publishing, etc.) which impact on the integration of current technology applications by teacher education faculty. The project can serve as a model for technology skill development for teacher educators.

The initial project was funded by the Bush Foundation, with subsequent system wide implementation funding also being provided by a Bush Faculty Development Grant. The continuance of the Bush project has been the development of a faculty teaming model to build upon the skills initiated through the Bush conference experience.

Overview of Staff Development Needs in Technology

Faculty in teacher education have a multi level need for skill development in the use of technology in education. Not only do they need to utilize appropriate technologies for the management and delivery of their own course work, but as important is the need to model and develop the skills and dispositions of their teacher education students for the appropriate use of educational technologies in their anticipated educational settings. Teacher education faculty often face difficulties in the acquisition of appropriate software and hardware and inservices to accomplish these needs. The reason for the extended difficulties lies in the fact that as members of the higher education arena, the inservice that is typically appropriate for other university faculty is only part of the inservice and resources that teacher educators need. Teacher educators need resources and a knowledge of strategies for the utilization of educational technology in the K-12 environment. They are also responsible for the development of appropriate skill development and disposition orientation of the teacher education students. The result is an extended need for equipment,resources,and staff development for teacher education faculty related to educational technology.

Faculty within the Professional Education departments as well as other teacher education faculty in specialty methods areas will need support in developing skills in accessing and using current technology resources. The first step in the learning process is to become aware and this awareness was initiated in the Spring 94 at Bemidji State University through a grant designed to bring together teacher education faculty from each of seven State Universities in Minnesota the " Bush Telecommunications Conference". The second step has been to practice and integrate the newly developed skills into the present teaching repertoire of faculty. This model describes a faculty teaming approach that enhances the development of technology skills for faculty in a positive professional non threatening manner. This model proposes to describe a method to provide faculty with the opportunities to learn new technology processes and to the apply them in their current educational setting.

Model Description

The model has four component parts, stage one: awareness goal development,stage two: curriculum integration, stage three: collaboration and inservice, and stage four: implementation evaluation. The first component involves the teacher in the awareness and development of basic educational technology applications in teaching. The second component provides the teacher with the opportunity to develop an understanding to the potential curriculum innovations possible with the use of the technology in the educational program. The third component provides the framework necessary for the educator to develop out-reach opportunities to share their expertise with other colleagues. The fourth component provides a forum for continuous improvement in the use of educational technology

Stage One: Awareness Goal Development

During the awareness goal setting stage faculty were brought together in a series of group awareness activities including equipment demonstrations, example strategies suggested by early users of technology in teacher education. Faculty were encouraged to team with other colleagues to identify common goals and skill building needs. A small amount of money was made available to faculty for the purchase of software resources. Faculty had the opportunity to pool their resources to fit their need requirements.

During the first component of the staff development model, faculty have the opportunity to develop background understanding of technology applications and their uses in instruction. This first component provides the educator with an in-depth experience with the educational hardware and software that is available in her/his teaching area. With this experience comes the development of skills necessary to use technology effectively in teaching. The focus of this component of development is instructional.

The teacher develops the ability to use technology in an instructional/management mode. The focus is on the applications of technology in the classroom. The many educational benefits of technology based teaching are experienced. At the end of this component of development the educator should feel comfortable in using some technology based teaching in their classroom.

Specific examples of activities in the first component include an in-depth analysis of available computer software in the various subject / grade-levels. An in-depth survey of the many uses of Internet is also a part of this phase of development. Educators become familiar with the different instructional uses of software such as utility programs, word processing, management, simulation, gaming, interview, and other instructional methods. Within each of these methods faculty develop skills in adapting software to classroom needs. The teacher options available on most modern educational software is also investigated. The individualization options of educational software and its enhancements to learning are explored.

With the advancements in telecommunications and the importance of this field to the classroom, faculty have the opportunity to develop skills in using e-mail, Gophers, World Wide Web Servers, as well as listservs, newsgroups and file transfer protocol. An analysis of the various methods of accessing and using the Internet is also a significant part of development.

Educational management options using computers are also analyzed during the first component of the staff development model. Advanced word-processing skills are developed along with the varied educational applications of word-processing. The use of data file management in educational management is also discussed. Spreadsheets and their applications in education are also explored. Educators develop the skills to manage test development, record keeping, grading, as well as improving their ability to communicate with other faculty, and students.

Educators have the opportunity to develop a project directly related to their teaching area. They are encouraged to be creative in their utilization of educational technology in their project. Projects have ranged from the use of HyperCard in record keeping, to using CD-ROM technology in presentations, to the use of e-mail to enhance communication among and between faculty and students, to developing an awareness of computer applications in music and art education. Educators are encouraged to develop skills in an area of their interest or where they have a need to incorporate educational technology to solve an educational or management problem. The major outcome of component one is the development of skills that have direct benefit to the educator and can be adapted into their educational program.

Stage Two: Curriculum Integration

The focus of the second component of the faculty development model is the development of curriculum enrichment with educational technology. This component provides the educator with an understanding of the applications of technology based education into the curriculum. The activities go beyond the application of technology in teaching and develop skills in the integration / modification of curriculum to utilize the benefits of educational technology.

Curriculum modification to utilize technology has had little support from faculty. Historically faculty have been reluctant to involve their students in any technology related activities. The primary excuse for this reluctance has been the lack of skill on the part of the faculty. Where students have been exposed to technology based education, it has been most likely in a separate program using a central computer lab taught by a computer teacher or coordinator. Usually there has been little coordination between the computer lab experience and what is going on in the classroom. This has resulted in meager curriculum modification. The computer experience has been seen as a separate activity with little relationship to the students on going development. Component two offers educators with the opportunity to integrate technology based learning into the regular curriculum of the classroom.

During the curriculum enrichment component of the staff development model, faculty develop skills in curriculum development. They focus on the potentials of technology based education and methods of modifying curriculum to include technology based education as a regular delivery method in the curriculum.

Stage Three: Strategy Integration.

During stage three, faculty review their present curriculum and course management needs. Faculty either in cooperation with a peer partner or in a formalized team teaching setting begin to integrate appropriate educational technology applications and management strategies. Examples have included electronic distribution of course syllabi, project descriptions, course resources, management of student work, display of student work in development in methods classes via large screen display,and continuous communication with students through e-mail.

During the inservice networking stage, faculty choose to attend a variety of workshops. Opportunities were available at the University level, off campus conferences, individual tutoring with experienced staff and or senior level technology students and cooperative learning sessions with peers. The "Bush Telecommunications Conference" provided a basis for faculty teaming and support both within and external to the institution of each faculty. In addition, the conference provided an opportunity for faculty to explore the potential of Internet resources, electronic mail for faculty and student communications, and electronic management of course communications and project activities. In addition to the conference activities, courses in educational technology applications and methods are taught by teacher education faculty. Faculty have elected to take these courses along with traditional students. This approach has provided scheduled access time with teacher education faculty who provide knowledge and skills that in prior instances were accessed informally or via "the service" role of the faculty member.

Component three also provides the educator with the opportunity to refine their skills and develop skills in the inservice of colleagues in using technology in their teaching. This educational technology inservice cadre component of the staff development model addresses the ongoing need of staff development in education. A major outcome of this faculty development model is the development of educators with the background and skills necessary to conduct staff inservice in the area of educational technology in their area, and be receptive to changes in technology and provide for continuous upgrading of those involved in the process.

The educational technology inservice cadre will provide a needed service to the educational community by making staff development available to a greater number of educators in addition to providing encouragement to those reluctant to incorporate technology based opportunities to their students. Having field based individuals involved in the updating of educational technology skills provides may benefits. Classroom faculty who have been successful in using technology in teaching provide an excellent staff development model to other faculty. They have an understanding of the limitations within their settings and are able to demonstrate strategies for overcoming those limitations. This does much to reduce many of the excuses that some faculty use. Another major benefit is that faculty have the opportunity to evaluate first hand the effectiveness of computer applications in the classroom. As a member of a cadre, they will have the opportunity to share their observations with other cadre members. This sharing of ideas will enhance the utilization of educational technology in education.

Stage Four: Implementation Evaluation

After the initial trial period experienced in stage three, faculty expand upon their use of educational technology applications. Faculty typically share their new knowledge with other colleagues thus creating a cascade inservice effect. The result has not only been an expansion of educational technology activities in the teacher education departments, but a positive faculty cooperative environment based on the common need to work with educational technologies which supersedes specific curricular territorial boundaries.

Once there is a significant mass of faculty incorporating educational technology applications into their teaching, it is possible to provide continuous evaluation and updating. With all of the emphasis being placed on teacher education to demonstrate continuous improvement, the ongoing assessment and continuous need to keep current with technology provides a visible vehicle for demonstrating continuous improvement to accrediting agencies such as state boards of teaching and NCATE.

Outcomes

Input from participants and others have identified several areas of positive outcomes from this development model for educational technology staff development. The following identifies some of the benefits of the model to the faculty member, the teacher education program, and to the University.

Benefits to the faculty member:

- Opportunity to develop educational technology skills that can be used in the classroom.
- Skills in upgrading and restructuring their curriculum.
- Opportunities and framework that supports sharing of skills and ideas with fellow faculty.
- Opportunity to upgrade teaching skills in a convenient time frame.
- Opportunity to earn graduate credit in an area of professional development need.
- Developing skills in using resources that are available after the training ends.

Benefits to the teacher education program:

- Capability of offering high quality and cost efficient staff development opportunities to a small number of faculty.
- Input into the staff development activities of their faculty.
- Greater utilization of educational technology resources in the teacher education program.
- Site specific training opportunities.
- Forum for sharing staff development needs with other teacher education programs.
- Continuous upgrading of instruction and curriculum.

Benefits to the university

- Better utilization of university resources.

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- Ability to deliver high cost training at reduced cost to the institution.
- Forum for addressing continuous updating of facilities.
- Opportunity to provide leadership in service region in area of educational technology.
- Opportunity for the recruitment of graduate students.

Summary and Future Directions

Periodic presentations in faculty meetings, noon technology times, informal technology problem solving, have proven inadequate to address the critical need to prepare teacher educators as model users and advocates for the use of educational technology for teaching. The possibilities of adding additional inservice time for faculty and the addition of course work for students is typically not a viable route for technology skill development.The infusion of appropriate use of educational technologies for the management and delivery of teacher education curriculum provides a holistic model for teacher education students. As we would advocate in the K-12 arena, educational technology is not an add on to the curriculum but a tool/method to be used by students and faculty for the delivery of instructional experiences. The concept of infusion and not add-on of technology is valid in teacher education as well. The department has holistically identified technology infusion as a priority throughout the delivery, management and conduct of the program. All faculty are encouraged to infuse appropriate use of technology into their course activities. Each faculty member sets individual technology development goals and are a part of either a small group or peer coaching team. The result has been a positive recognition of the program at the local, state, and national level. More importantly it has resulted in pride and collegiality among faculty.

An ongoing dialogue on the issues related to technology in education as well as the basis for an integrated staff development program provide a staff development model that can be used in other educational program areas as well. Making quality staff development opportunities available to educators is a major concern of teacher education institutions. Developing a framework to facilitate and ensure the delivery of quality programs is the major outcome of this staff development activity.

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METHODS & CONCEPTS

This year's submissions on practices in the profession can be readily classified on the basis of their primary foci: four concentrate on classroom students and activities, three revolve around practices in teacher preparation and inservice training, and the remaining three deal with a variety of other issues. Since this section reports on practices in the profession, the papers are generally descriptive in nature, typically small case studies.

Student and Classroom Activities

It is a truism that contemporary society is faced with complex problems, and as educators we must equip our students with the intellectual tools to confront and solve (or at least satisfactorily deal with) the complexities of modern life. In the lead paper by Donn Ritchie, Peter Norris, and Gina Chestnutt of San Diego State University, *Incorporating Technology into Problem-Based Learning*, the authors describe difficulties in creating learning activities that are appropriately representative of those that real people face in their real lives. After describing the difficulties that teachers face, the authors proceed to describe public domain computer software that teachers can use to assist in the formulation of problem-based scenarios.

In *Computers in the Classroom: A license to skill*, by Christine Bennett of Eastern New Mexico University, and Jerry Bennett, Pamela Tipton, and Curt Tarter of the Roswell Independent School District, the authors describe a not atypical situation where the computer knowledge and sophistication of students is extremely heterogeneous, as is the sophistication of teachers. To deal with the problems of students using computers in ways that exceed their knowledge base, and occasionally wrecking configurations, the authors developed a "license" system, in which three skill levels are identified, and students who can demonstrate competency at that level are issued a "license". The authors report enhanced student motivation and a more stable computing environment.

Dorothy Erb and Constance Golden of Marietta College (Ohio) describe a project that employs technology to assist as-risk fifth, sixth, and seventh grade students. In *Establishing Technology Communities for At-Risk Students*, the authors explain how Marietta College education and psychology majors are trained in the use of technology, communication leadership, and mentoring skills. These students, in turn, work with at-risk students who carry their newly acquired skills back to the classroom to assist their peers. The authors report increased technical knowledge in both the college and school students and increased self-esteem and communications skills on the part of the at-risk students.

In *Making Connections: Using information technology as a vehicle for restructuring curricula*, Gail Grejda of Clarion University (Pennsylvania) describes a cooperative project in progress, designed to train teachers to develop a capstone experience for high school seniors. The students, working in teams, are to research, design, and produce a multi-media presentation on a local historical topic. Interdisciplinary in nature, the experience demands competence in historical, mathematical, writing, illustrative, and creative skills.

Teacher Preparation and Inservice Training

These three selections all focus on the technology training of new teachers, and upgrading technological skills of the existing members of the profession.

Tech Camp: A model for Integration of Technology and Education by Katherine Will, John Clementson, and Oscar Will III, describes a summer inservice training institute that is a joint venture between Augustana College and the Sioux Falls (South Dakota) school district. The authors report the project had very salutary effects for both the school district and for the college.

Cheryl Moser from the Center for Education and Training in Mobile (Alabama) presents the plans for a new inservice training center in that city, and describes the center's structure to date.

In *One Teacher Education Program's Answer to Technology Integration,* Lorana Jinkerson of Northern Michigan University lists the factors that were involved in her department's educational planning process.

Other Issues

Growing Our Own: Database Tending in Colleges of Education by Gary Schroeder is a description of the efforts of the College of Education at Murray State University to develop its own database system. The paper chronicles the department's efforts over a number of years, and its eventual migration to a relational database design. Schroeder offers a number of concrete suggestions as a result of the Murray State experience.

Gregg and Nancy Brownell of Bowling Green State University chronicle the difficulties they and their school partners experienced in attempting to publish a technology text employing contemporary electronic desktop publishing tools, but dealing with a publisher that was not at the technological forefront. *Publishing Partners: A University/School Collaboration to Publish a Technology Text* recounts their effort, their successes and their frustrations, and offers advice to others who may be contemplating a similar venture.

The final selection by Thomas McManus of the University of Texas at Austin, is a description of the Globewide Network Academy, a not-for-profit corporation that seeks to evolve into an accredited college that delivers all of its instruction electronically, presumably via Internet. The venture is off-the-ground, fully incorporated, and presently offering two experimental courses.

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Incorporating Technology into Problem-Based Learning

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Throughout our lives we encounter ill-defined challenges that require us to draw upon our problem-solving skills to reach effective solutions. Although most educators agree that problem solving is a critical skill, teaching students to solve realistic problems has often been amiss in our educational institutions. This article examines the theory and recent changes in problem-based learning, considers the implications of problem-based learning in pre-service education technology classes, and describes available public domain software. This software assists instructors with the formation of problem-based scenarios and provides students a robust environment in which to analyze problems, synthesize solutions, and evaluate their findings.

Introduction

One of the most critical tasks we inherit as educators is preparing students to solve spontaneous, real-life problems as they engage in activities outside the classroom. Recent national attention has focused on this issue by declaring the need for schools to help students increase their ability to reason and solve real-life problems (US Department of Education, 1991; US Department of Labor, 1992). Even though many of today's complex issues are within the realm of student understanding, the skills needed to tackle these problems are often missing from classroom instruction. This neglect may be due to one or more of the following reasons; teachers may not understand the importance of activities which promote problem solving, teachers may not know how to generate appropriate problems or establish classroom activities conducive to problem solving, or the additional time required to implement problem-based learning may not appear justified in an already busy schedule. The purpose of this article is to address these concerns by providing background information on problem-based learning, exploring conditions that maximize the transferability of classroom activities to real-life problems, and describing a recently developed tool designed to assist teachers and students in creating and solving problem-based learning scenarios.

The importance of Problem-based Learning

Children need to assimilate higher-level thinking strategies and skills to anticipate and solve problems in the emerging high-performance work place of the future. Currently, teaching strategies such as problem-based learning, deductive and inductive reasoning, stages of moral development, ethics education, collaborative learning, metacognitive skills, and habits of mind all contribute to developing critical thinking skills by taking student beyond the learning of simple facts, concepts, and procedures (Stepien, Gallagher, & Workman, 1993). One of the most useful of these strategies is problem-based learning (Barrows, 1985). Not only does this method accentuate acquisition of content-relevant knowledge, but also increases students' ability to transfer critical thinking skills to new domains. The ability to solve problems, however, is more than just accumulating knowledge and rules, it is the development of flexible, cognitive strategies that help analyze unanticipated, ill-structured situations and produce meaningful solutions.

Unfortunately, instruction to help students develop skills that will help them solve real-life problems is seldom included in classroom activities. When problem solving is taught, it tends to be situation specific and non-transferable. Typical problems are well defined, require a specific algorithm for their solution, and have one right answer provided by an expert. In these situations, it is often the procedure required to solve the problem that is the focus of instruction. Examples of these well-structured problems are commonly referred to as word problems: "Two trains leave stations 1264 miles apart at exactly the same time. Train A travels in an easterly direction averaging 53 mph. Train B . . . ."

Well-structured problems, in which there is only one right answer, simply teach students *about* problem-solving, not *how* to problem solve. In real life, we seldom repeat exactly the same steps to solve problems; therefore, the lock-step solution sequence taught in traditional classrooms is seldom transferable. Real-life problems present an ever-changing variety of goals, contexts, contents, obstacles, and unknowns which influence how each problem should be approached. To be successful at solving these problems, students need practice solving ill-structured problems that reflect life beyond the classroom walls.

Designing Relevant Problems

Problem-based learning can help bridge the discrepancy between skills normally demanded in school (memorizing and recalling facts) and those required to function effectively in life outside of school—identifying problems, gathering and analyzing data, and developing and implementing solutions to those problems (Reich, 1993). Problems that have been found to be the most successfully used to teach problem solving exhibit realistic and contextualized situations, require active engagement, include key concepts or processes to master, extend over time, and require that solutions include the development of a product (Krajcik, 1993). In this section, each of these components is examined.

Realistic and contextualized problems should mimic as closely as possible the external environment. These problems tend to be complex, ill-defined, and have more than one right answer. Incorporating real-world contexts and consequences not only allows learning to become more profound and durable, but provide an apprenticeship to solving real-life problems (Stepien, Gallagher, & Workman, 1993). One way to help increase realism and blur the distinctions between academic life and life after school is to tie the problem to current events or dilemmas facing the global, regional, or local society.

Problems anchored in realistic and relevant situations, by their very nature, entice students to become actively engaged in their solution. To help ensure engagement is challenging and focused, checkpoints should be used to verify student progress. Having students restate the problem, identify what is known and unknown, design plans to collect and analyze the data, develop and evaluate potential solutions, and share their ideas and conclusions can all be used to ensure students are keeping on task.

Because students assume a greater responsibility and self-direction in problem-based learning, it is important that the initial problem be structured so as to guide students towards discovering relevant content by the conclusion of the activity. A helpful technique is first to identify the content knowledge to which you want students to be exposed. From this list, potential problems can be generated that will lead students from their current level of knowledge to the desired results. Finally, support material and resources students may require during their exploration can be identified, and when applicable, gathered. By first identifying the desired end results, then working backwards to identify a relevant problem, the probability that students will attain the needed skills and knowledge is increased.

Another variable to incorporate in the problem is the complexity often encountered in real-world problems. This can be accomplished by presenting problems that are composed of multiple parts and will engage students over a period of time. Through practice with complex, ill-structured problems in the classroom, students often realize that many of life's problems that initially appear insurmountable are more easily managed when divided into subproblems and systematically addressed.

Finally, at the completion of the problem, students should bring closure to their activity by creating products that demonstrate their knowledge. Sharing conclusions or products with teachers, students, parents, or the public provides not only an audience to judge the worth of their solution, but also raises the process from an academic exercise to one that more accurately reflects real problem-solving procedures of adults.

A New Role For Teachers

Adopting problem-based learning necessitates a transformation in the teacher's role from information disseminator to facilitator of student directed learning. In addition to developing an engaging problem, the teacher's major tasks include supplementing normal classroom materials with access to external resources, facilitating cooperative teams dynamics, serving as mentor and cognitive coach, and expanding their assessment of student learning.

In problem-based learning, students are changed with identifying, discovering, and analyzing much of the information required to reach a solution. In addition to having relevant materials in the classroom, it is important for teachers to establish contacts with supportive community experts who can respond to student inquiries. It is also helpful to provide a list of other sources of information such as electronic databases, libraries, and museums.

To help reflect common work environments, teachers often establish and help manage student teams to address their problem. Cooperative teams allow individual members to increase their cognition as they share information, analyze data, express opinions, receive feedback, hear alternative perspectives, discuss findings, and elaborate on their own knowledge representations (Gallagher, Stepien, & Rosenthal, 1992).

The teacher's role is also to serve as a cognitive coach who supports, rather than dictates, the learning process. Common activities include asking probing questions to stimulate the students' quest for information, and encouraging experimentation and discovery learning. Teachers should also encourage students to monitor their own problem-solving processes by having them reflect on their progress and understanding. These activities help strengthen student's cognitive processing skills in critical thinking, reasoning, and decision making.

Finally, teachers need to broaden their perceptions of student success by acknowledging achievements gained through the process as well as from the outcomes produced. Traditional methodology typically rewards student successes for uncovering the one right answer to each problem. In problem-based learning, typical assessment also considers active engagement with resource materials, exploration strategies, critical thinking, and reflective analysis (Martens, 1992).

Problem Solving in a Technology Classroom

Problem-based learning has become an integral part of the technology curriculum for pre-service educators at San Diego State University. Within the curriculum are a variety of short-term (completed in one session), intermediate-term (completed before the next class), and long-term problems (completed over multiple weeks).

A recent short-term problem had students identify what they would do if given $20,000 by their building administrator for technology. Along with the problem statement, students were provided with computer supply catalogues and articles detailing the need for more than just hardware and software for successful technology integration. Students worked in small groups to determine what type of monetary allocation would be best for their circumstances. After completing the assignment, the groups took turns describing, justifying, comparing, and contrasting their results.

An intermediate-term problem was an invitation from a fictitious school district requesting current resumes for teaching positions. Because the students had recently learned how to incorporate a variety of styles in their word-processing documents, as well as how to scan and import graphics, they were encouraged in the letter to "be creative." Course instructors suggested that students contact their building administrator as well as the university's career service to gather ideas on acceptable resume formats. Successful strategies and results were shared when the students returned the following week.

A semester length problem required students to plan an entire day of classroom teaching in which technology was integrated in relevant ways as often as possible. Throughout the semester, students were encouraged to reflect on how various strategies and technologies presented could be merged into their technology day. Again, students shared results at the completion of the course. This activity helped students discover and formulate a multitude of strategies for technology infusion within a specific domain.

In addition to receiving problem-based learning during their instruction, students are encouraged to implement these procedures in their own teaching. Unfortunately, teachers frequently lack sufficient time or knowledge to generate relevant and robust problem-based learning activities. Also, their students will often lack the metacognitive skills needed to gather and analyze data, generate and test hypotheses, and evaluate, justify, and present solutions to problems (Stepien et al., 1993). To help minimize these obstacles, a technology tool has recently been developed on the Macintosh™ platform to assist instructors and students in the creation and use of problem-based learning. The template, known as the Problem Solving Assistant (PSA), was initially designed to promote problem-based learning for science students in middle school using an anchored instruction approach similar to that used in the Jasper experiment (Cognition and Technology Group, 1992). Because the template is not content specific, it can be used in a variety of subject areas and with a variety of age groups.

The PSA presents its users with a "study room" metaphor that is intended to simulate an environment where students would typically conduct research in pursuit of a problem solution (see Figure 1). The study room provides a relevant, context-rich learning environment in which students experience near-authentic situations. The study room metaphor has been incorporated not only because it represents a context with which students are familiar, but because metaphorical representations have been found to facilitate learning and far transfer of knowledge (Andre, 1986). The room has a variety of research resources including reference books, CD-ROM player, television, videodisc player, telephone, computer, and bulletin board. As students interact with these objects, they become actively involved in the learning process by analyzing the problem, collecting relevant data, and deriving solutions. This active involvement helps knowledge acquisition become personal, meaningful, and memorable. meaningful, and memorable. The PSA contains two modes of operation, an "author mode" and a "user mode". In the author mode, instructors embed conceptual and procedural information within the study room for student discovery. The PSA provides a high degree of atomization to aid in the addition of this information, allowing the instructor to concentrate on the adaptation of materials and not on the mechanics of constructing a rich environment.

In the user mode, the PSA guides students through the process of formalizing a description of the problem, gathering and analyzing data, synthesizing and evaluating solutions, and presenting results to classmates. Students gain access to information by clicking on objects found in the study room. For example, to read instructor embedded text, students click on one of the textbooks on the bookshelf; to see a QuickTime movie, students click on the TV; to hear an audio clip, students select the telephone. Information

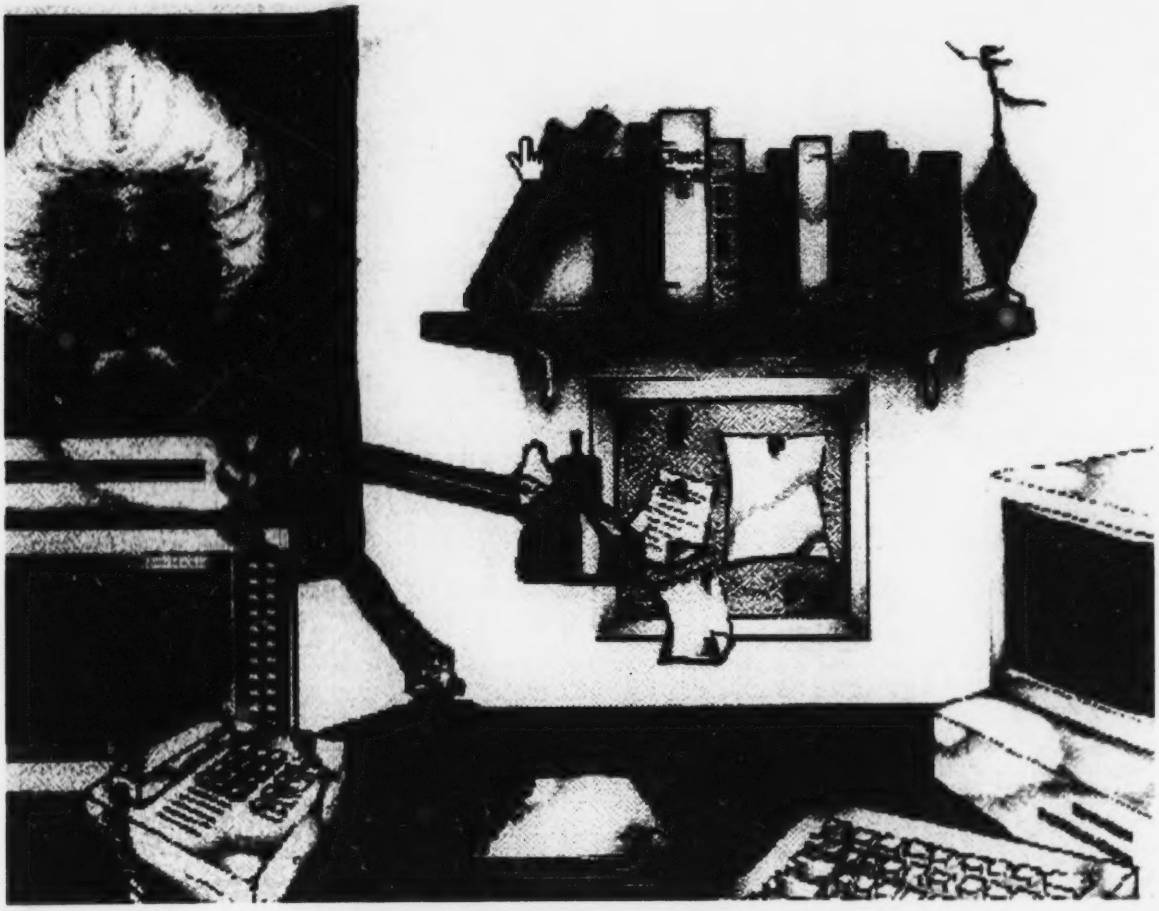

Figure 1. Study Room in the User Mode

provided by the teacher may provide relevant information to solve the problem, clues to external resources, or lead to dead ends.

An important component of the PSA learning environment is found on the bookshelf and is known as the "Problem Log". The problem log guides users through an eight-step problem-solving heuristic. This heuristic prompts students to redefine the problem in their own words, delineate personal knowledge which may be used to reach a solution, break the problem into manageable subproblems, identify where pertinent information to the problem may be found, collect and analyze relevant data, generate potential solutions, evaluate the advantages and disadvantages of each potential solution, and determine the best solution. Each step in the heuristic has been included to help develop the cognitive capability of the students.

The log book's first prompt encourages students to restate the problem in their own words. As students examine and redefine the problem, they mentally transform a representation of the problem into personal memory structures, thereby making the problem and related knowledge more meaningful (Andre, 1986). Next, students are prompted to identify personal knowledge of the context, content, or other characteristics that may be relevant. This procedure activates prior knowledge and, when done as a group activity, provides new information to students as their communal knowledge evolves. Students are then asked to break the problem into subproblems. This iteration helps students conceptualize the problem, and makes the problem-solving process more manageable.

The fourth prompt encourages students to expand their research options by identifying where required knowledge to solve their problem may be secured. With access to on-line optical storage devices, audio and video clips, graphics and pictures, and text-based resources through their study room interface, and outside resources such as library books, telecommunications, and community experts, students should be able to identify a wide variety of sources from which to collect information.

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Next, students are prompted to gather and analyze relevant data. This step often illuminates areas of conceptual weaknesses and serves as a springboard to identify additional areas of knowledge that must be attained before the problem can be solved. Eventually, data collection reaches a point at which students can begin to synthesize potential solutions. Because problems rarely have one solution, the log book prompts students to generate several alternatives. Students are then prompted to evaluate solutions by identifying advantages and disadvantages of each. The final step requires students to rank their solutions.

When students complete the log book, the PSA consolidates their information and assembles it in a format suitable for presentation. In addition to merging the problem, subproblems, data, and solutions into an editable format, the program provides a summary screen for closure. Together, the components in the PSA present the problem to the students, allow opportunities for exploration, prompt students through a problem-solving heuristic, and structure a presentation.

Summary

Problem-based learning is an instructional strategy used to help learning become more personal and memorable. In problem-based learning, students are presented with ill-formed problems that do not require attainment of one "right" answer. Because these problems tend to mimic real-life challenges, knowledge gained through problem-based learning is often more transferable and generalizable than knowledge gained through more traditional instruction.

To assist the design, development, and implementation of problem-based learning, a software tool has been created. To receive a free copy of the software, along with a 27 page teacher's manual, contact the author at dritchie@bestsd.sdsu.edu.

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Computers in the classroom: A license to skill

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The potential of technology to revolutionize instruction is evidenced by reports that computer use increases students' achievement, positive attitude, attendance and motivation while it decreases discipline problems (Dwyer, 1991; Shields, 1993; White, 1989). School districts across the nation are undergoing metamorphosis as they strain to break free from the traditional educational paradigm and establish a new technological identity.

Many educators are being led to believe that purchasing machines will turn their schools into "Information Age" institutions of learning, but the purchasing of hardware and software, introductory computer classes for teachers, and administrative encouragement is not enough to help schools escape from their cocoons. Successful integration of technology into classrooms requires district support and individualized school programs designed to meet the needs of teachers and students within their educational context (Braun, 1993; OERI, 1993; Ritchie & Wiburg, 1994; Scrogan, 1993).

This paper presents a program designed to help teachers and students increase skills in the use of computers in the classroom. The paper describes the background of the program and the development of an elementary school "computer license project" designed to allow teachers to determine student computer proficiency without taking class time for assessment.

District Technology Initiative

The Roswell Independent School District, in Roswell, New Mexico, has had a technology initiative for the past three years, an outcome of community forums designed to improve the educational system. The community, Board of Education, administrators, and staff believe that, in order for our students to be prepared for the challenges of the twenty-first century, they must be proficient users of technological tools. Pamela Tipton was hired by the district as the Director of Instructional Programs to supervise the integration of technology into the curriculum.

The results of an October 1993 Technology Needs Assessment showed that both the teaching staff and administrative staff desired to see an increase in student use of computers and staff training in using technology. The staff believed that computers would have a positive impact on education. Ninety-four percent (94.1%) said that computers would improve student learning and/or achievement. A vast majority (88.7%) agreed that computers could improve the way teachers work or instruct. Training in technology use was requested by 87% of the respondents.

The school district made an initial response to the challenge of incorporating technology into the instructional program by developing an instructional technology long-range plan and curriculum guide to guide the distribution of technology provided by community-supported funds. Workshops and summer technology institutes had been offered to teachers; however, impact on the instructional programs was limited. Too many computers remained sitting unused in the back of the classrooms, or were used by students only for rewards or games.

A Partnership is Formed

In the fall of 1993, Eastern New Mexico University and the Roswell Independent School District began collaboration in the development of inservice programs that would support technology integration in the schools. Dr. Christene Bennett, Assistant Professor of Education, and Pamela Tipton worked together on district technology goals and developed a technology inservice program for administrators. They discovered that technological development with a veteran staff would need to take many different forms and venues in order to be successful. In the meantime, Jerry Bennett, a part-time ENMU-R instructor in teacher education and technology, called several neighborhood school administrators and offered to assist them with some of their technology problems on a voluntary basis. One elementary school principal, Curt Tarter from Berrendo Elementary , enthusiastically responded by asking for whatever assistance seemed appropriate. Jerry attended a staff meeting in September 1993, and was introduced by Curt as someone who could help staff learn technology and help them integrate technology into their teaching.

Several weeks passed with no calls for Jerry's assistance. Finally, one third grade teacher called saying her computer was broken and asked for help. The problem was that the correct software hadn't been loaded on to the machine. As Jerry walked down the hall, two other third grade teachers asked for lessons after school in how to use computers. After two months, one of the teachers said, "Jerry, we would have called for help earlier but we didn't know what to ask for." So began a slow process of the beginnings of breaking through what we call "the technology fear factor" which seems to paralyze many teachers as they struggle to learn about technology.

Jerry returned weekly throughout the year giving individual instruction, working through software and hardware problems, and working with children on an individual basis. Since he is also a certified teacher, he taught on a substitute basis in some of the classrooms. He also visited several classrooms and worked individually with students. After several months, there was still considerable lack of use of computers even though most classrooms had one. Many teachers found it overwhelming to learn a new skill while trying to keep up with all the current demands of teaching in the 90's.

The Problem Solving Process

In an effort to increase computer use by teachers, Curt, Jerry, and Christene worked as a school-university team to review the equipment and training needs of the school. Berrendo Elementary School had one Macintosh in each classroom. Each machine had Claris Works, Hyper Card, and Grade Book Plus loaded on it. The team was aware that few teachers had adequate training in the use of either the machines or the software. Many were reluctant to go to training workshops outside of their own school and expressed frustration with trying to learn in large groups on equipment dissimilar to their own.

One of the difficulties expressed by our teachers is that they did not have a way of evaluating student expertise with computers. Many students could use a Nintendo or an IBM, but were not proficient on a Macintosh. Even if students knew how to operate a Macintosh, there was no way of knowing what software the student knew how to use. Teachers found that if they gave students permission to use the computers, they would get side-tracked with the multitude of questions that accompany a neophyte computer user trying to run unfamiliar software and hardware. As a result, computers in the classroom became a management nightmare.

The students were very anxious to use the computers, but many of the teachers were unable either to use the computers themselves or to integrate their use into curriculum. Since the district requires principals to evaluate teachers' use of technology in the classroom, there was considerable desire on the teachers' part to learn. The school-university team worked together to develop a plan that would 1) allow students to use the machines without creating technological migraines for novice teacher computer users, and 2) allow teachers to progress with their own learning at an individual pace.

The Computer License Project

To help solve this problem, the school-university team devised a Computer License program in which students at Berrendo Elementary learned basic computer skills, then demonstrated their ability by taking a hands-on test. If they passed the test, they were awarded a Level I, II, or III computer license with their picture on it. Then, if a student at Berrendo Elementary asked to use the computer, all the teacher had to do was ask if he or she had a license.

The three levels of computers licenses are described below:

A *Level One* License certifies that the student can turn the computer on and off correctly, can initialize a disk, can launch an integrated software program and begin and save a word processing document, and can initiate the Apple II 5.25" disk drive and program.

A *Level Two* License indicates the user can work with WP documents, initiate a Data Base fill and manipulate the data, create a graphics document, and create and manipulate data in a spread sheet. The student can launch HyperCard and create a new stack with visual and sound effects.

A *Level Three* License indicates the holder can work with animated stacks in HyperCard and use advanced techniques with an integrated software program. The student can use a CD-ROM disk for research data retrieval and transfer the data to a work processing document; can research material on a Laser Disk and import the data into a WP program; can retrieve data from ExPress and use it in another program; and can capture video with a camcorder and import it into a WP document.

Implementation

During the latter half of the 1993/1994 school year, Jerry provided technology workshops for teachers and instruction to a limited number of students in the building.

Students were grouped in pairs for training so that if they forgot a command, they could collaborate to find solutions. Students were given an opportunity to practice what they'd learned in their classrooms. When the students felt ready to take the test, they asked their teacher or principal to schedule a test. The test became extremely popular with the students and is the only test in school that continues to be happily requested on a regular basis. Teachers who once were reluctant to work with computers are now asking for training and assistance.

Beginning January, 1995 Jerry will work with a whole classroom at a time, providing the classroom teacher and students with three hours of instruction on the preliminary use of integrated software. This will give teachers the opportunity to participate in both the delivery and receipt of instruction. Computers from other classrooms will be moved into a central location so that a one computer to two students ratio can be obtained. At the end of the session, a hands-on computer competency test will be given to students for a license.

Conclusion

There are several key elements required for a computer license project to succeed. The school needs adequate hardware and software. The district must support both training and use of technology in its schools. The principal must see a need to assist teachers and students in this rapidly changing field. Educators knowledgeable in both technology and education are needed to work with teachers and students as they acquire new skills. Teachers must be willing to be patient with both their students and themselves while a new classroom learning climate evolves. A program such as the Berrendo Elementary computer license project gives students more computer access and training, while giving teachers time to develop skills through inservice and collaboration.

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Establishing Technology Communities for At-Risk Students

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Educators have recently voiced concern over what appears to be a widening gap between students who have rich experiences in the use of technology as a tool for learning and students who have little, if any, opportunity for hands-on technology experiences. This problem is particularly evident in southeastern Ohio where student exposure to technology in schools is limited and socioeconomic status has become a determining factor separating the Òtechnology havesÓ from the Òhave-notsÓ. Marietta College is seeking to address this problem through a number of programs using technology as a tool for learning. These programs bring together preservice teachers and at-risk students into technology communities.

Student Mentoring Corps

The Marietta College Student Mentoring Corps project is one example of the technology community emphasis. In an effort to bring technology to students who are at-risk for academic and social reasons, Marietta College has established a student mentoring program through a Mentoring Corps grant. The purpose of the program is to use technology with small groups for collaborative hands-on activities that aim to improve the academic, social and emotional needs of economically disadvantaged and academically at-risk youth. The most important component of this project is the formation of a ÒJunior Mentoring CorpsÓ for all children who participate in the project.

Marietta College education and psychology students work with 72 fifth, sixth, and seventh grade students from two Marietta City Schools two afternoons a week in the afterschool mentoring corps program. The college mentors enroll in a course which meets weekly to teach the technology, communication, leadership, and mentoring skills necessary for the afterschool program. The college students then teach these skills to the younger students, thus forming a "Junior Mentoring Corps". The junior mentors take their newly learned skills back to their classrooms and teach their peers the technology applications used in the program, as well as the use of effective communication and leadership skills.

This program has yielded positive results for both college and at-risk students in several ways:

1. computer knowledge and skills for both groups have improved;
2. the increased status that the junior mentors have achieved has improved their self concept;
3. social and communication skills of junior mentors have improved; and
4. junior mentors have had opportunities to interact with technology , thus narrowing the technology equity gap.

Summer Reading Clinic

Technology plays an integral part in the learning communities established during the Marietta College Summer Reading Clinic. This Clinic is a five week summer program designed to enable teacher education students to apply skills in diagnosis and correction of reading disorders with academically at-risk students. An integral part of the

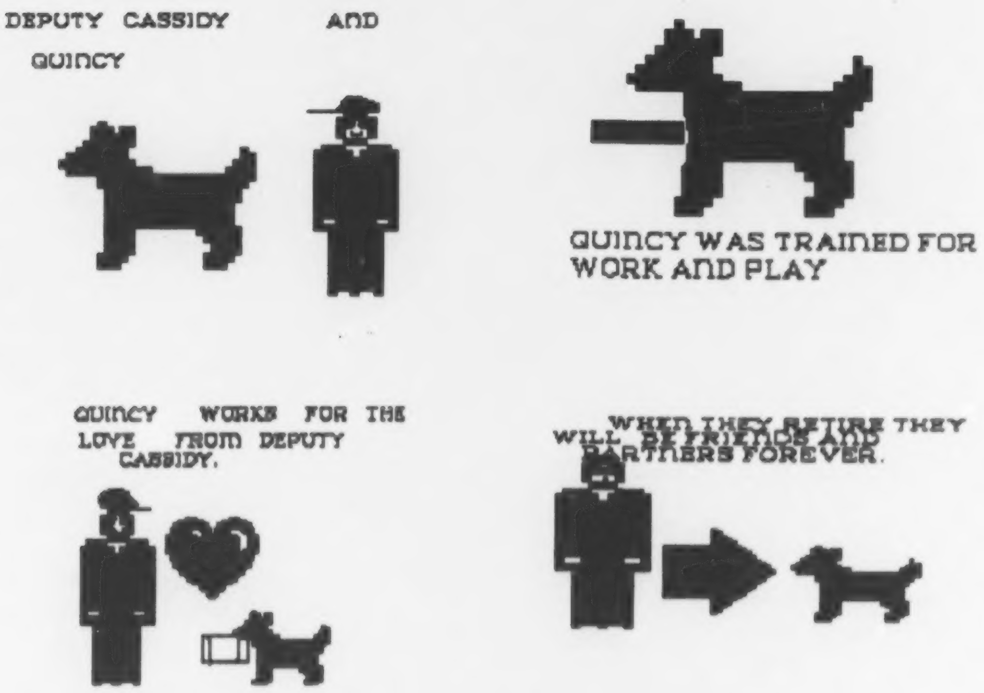

Figure 1. Portions of a slide show created with KidPix2 by students. The slide shown is based on a visit from a sheriff's deputy and his drug dog Quincy.

clinic involves the use of technology to motivate students and enhance the learning process. Technology and children's literature are integrated by teacher education students to encourage the children to respond to reading in creative ways. Using multimedia authoring software clinic teachers build response stacks for children's literature. These stacks encourage children to respond orally, in writing, and in pictures to literature read in the clinic.

Children's writing is enhanced through the use of writing and multimedia applications for children. Using children's word processing applications, clinic students take delight in producing professional looking, printed stories complete with graphics. Experiences during the clinic provide an impetus for students to use multimedia programs to create narrated slide shows. (see Figure 1) Students proudly present their slide shows to parents and friends at the conclusion of the clinic.

Afterschool Science Program

The Women in the Sciences (WITS) program seeks to provide opportunities in math and science for economically disadvantaged middle school students who show academic potential for success in this area. The majority of the students in this program have had minimal experience in the use of technology as a learning tool. Grants from the federally funded Eisenhower Math and Science Program have enabled WITS to offer afterschool and summer programs providing hands-on math and science experiences.

WITS students work in pairs in the afterschool program using CD-ROM and laser video media as well as traditional print material to research information on a selected scientific focus area. Multimedia presentations are created by participants to present this knowledge at the conclusion of the program. These presentations incorporate scanned images, digitized photos, Quick Time movies, recorded sound, and laser video.

Teacher education students work in the WITS program as session leaders. Responsibilities include planning biweekly sessions to introduce the students to technology and multimedia. College students work as a team to determine how to present material and organize the sessions. After introducing hypermedia to the WITS students, the teacher education students assist them in the research and creation of their presentations.

This program has yielded positive results for both the WITS student participants and the teacher education students. Classroom teachers report that some of these students do not succeeding in school due to lack of motivation and other problems. These problems which exist in school for some of the economically disadvantaged students are not evident in this program. Use of technology is a motivating factor that contributes to creative outcomes in the presentations. Teacher education students gain the opportunity for hands-on experience in using cutting edge technology with real students. Issues such as direct instruction in technique versus allowing the students to experiment with the technology are addressed by the teacher education students in a realistic, meaningful situation as each session is planned. While assisting the WITS students with the creation of their multimedia projects, teacher education students broaden and refine their own expertise with technology.

At Marietta College, the use of technology with elementary and middle school students is founded in the fundamental beliefs held by the Education Department. The belief that technology is a tool for meeting the needs of diverse populations of learners is evident in technology communities. The belief that preservice teachers need to have authentic experiences in applying technological knowledge and skills serves as a basis for work with at-risk students. Finally, the belief that the teaching force of the twenty-first century will need to value the use of technology as a learning tool is evident in the design of preservice experiences with children.

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Making Connections: Using Information Technology as a Vehicle for Restructuring Curricula

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Within the next two years, as mandated by newly established Pennsylvania Outcome Based Education guidelines, high school seniors will be required to demonstrate competency in a range of areas including technology, critical thinking and communications. In order to meet this challenge, an interdisciplinary team comprised of university professors and high school teachers worked collaboratively to design and implement an outcome based Senior Capstone Project that would afford students the opportunity to develop and demonstrate the outcomes required by the state. The project, which involved high school seniors in the research and development of a multimedia presentation of the history of the school and its historical relationship to world events, developed a range of competencies and restructured the roles of both teachers and students. It also afforded rural secondary teachers the opportunity to explore new methodologies across and within disciplines and to use information technologies as a vehicle for restructuring Social Studies and English curricula. It enabled students to develop knowledge of and an appreciation for the interconnectedness of disciplines along with the necessary research and technological skills to prepare them for today's world.

The optimal outcome of the project was the development and implementation of an instructional model which used technology to redefine the traditional roles of teachers and students as active partners in the learning process. Believing that technology was the key component in fostering this change in the traditional roles of teachers and students, an interdisciplinary team of the high school teachers requested assistance from members of the university community in the accomplishment of their goal.

Planning the Project

Numerous brainstorming sessions attended by both secondary and university team members resulted in the development of the *Senior Capstone Project*. The thrust of the project involves high school seniors working in collaborative groups within the social studies and English classes studying the history of the school and its historical relationship to world events. The focus of the first year is the history of the school; in subsequent years, students may choose another topic such as the history of a local industry, of the university and its impact on the town, or perhaps a history of the town itself. The culminating activities will be a journal and a multimedia presentation.

Two grants were co-authored by the participants: a national grant for hardware and software and a state level grant for training and staff development. The state grant for approximately $6500 was funded; the national grant was not.

College professors with expertise in historical research, pedagogy and educational computer applications assisted secondary teachers in expanding the scope of the high school curricula and in assuming new roles as classroom facilitators. The secondary faculty also met as an interdisciplinary team to define project goals:

A. Skills

The students will:

1. use appropriate forms of technology to collect, analyze, organize, evaluate, and communicate information and ideas;
2. develop analytical skills by practicing problem solving and informed decision making;
3. develop interpersonal skills through training in interviewing techniques and oral presentation;
4. develop communication skills through writing and editing a documentary; and
5. develop and apply historical research skills by gathering data about the school's history and integrating it into the context of national history.

B. Attitudes

The students will:

1. develop self-esteem through exploration of the students's own school history;
2. develop respect for the dignity, worth, contributions and rights of others as they work cooperatively with team members, faculty and members of the community as they work toward the completion of a common goal; and
3. acquire an appreciation for the interconnectedness of disciplines.

College teachers, in turn, established their own project goals:

A. a closer professional relationship with the local school district,
B. an opportunity for preservice education majors to experience the relationship between learning theories and current classroom practices, and
C. additional early field experiences for secondary education majors.

The Senior Capstone Project

The anticipated outcomes of the *Clarion Senior Capstone Project* for the 1994-95 academic year are a journal and hypermedia presentation of the history of the school and its historical relationships to world events. High school seniors, working in teams of four, are conducting in-depth research of the history of their school, exploring such areas as community and school demographics, extra curricular activities, curriculum, teacher qualifications and expectations, and career patterns. Working with members of the community (e.g. retired teachers, former graduates, former administrators and school board members, and long-time residents), the seniors are gaining a greater understanding of primary research and an appreciation for their school and community. Using facilities such as high school records, university services, community libraries and the historical society, yearbooks, community and school newspapers, CD-ROM, network services and personal interviews, students are researching and gathering data on their selected subject . Student journals documenting the progress and findings of their task are also being maintained. Video interviews, photographs and other memorabilia, collected by the students are being incorporated into their group projects. Each group is responsible for synthesizing, organizing and presenting their data in a written report at the conclusion of the first semester.

University students presently enrolled in English and Social Studies methods courses serve as team leaders for the teams of high school seniors, thus experiencing the relationship between learning theories and current classroom practices. English majors read and comment on the weekly journal entries while Social Studies majors assist students with the locating, collecting, organizing and presenting of data.

During the second semester, students will combine their group efforts and produce a journal, hypermedia presentation, and a permanent display of the photographs and memorabilia collected during the project. This will be their legacy to the school and future students.

Training the Participants

The project partners have a longstanding collaborative relationship through their efforts to provide quality field experiences for preservice teachers and through their desire to strengthen basic education. Secondary faculty service the university as cooperating teachers, consultants and as members of advisory boards; university faculty provide inservice workshops, classroom presentations and consultant services. Perhaps the most notable collaborative effort was the 1989 *Clarion Writing Project*, a grant which resulted in the training of high school English teachers in writing-as-process theory and its classroom applications and the founding and implementation of the school's writing lab. The project involved extensive training and exchanging of ideas between institutions, visitations to observe process-writing models both in the university and public school classrooms and collaboration to develop new techniques to solve pedagogical problems. The *Clarion Writing Project* continues today as a successful model of the writing-as-process paradigm.

Professional development needs for the Senior Capstone Project followed a similar format. University professors helped train their secondary partners in the use of technology, while, together they developed new methodologies for assisting students in the use of technology as a tool for independent learning. Secondary teacher participants attended workshops on *ClarisWorks* applications at the new Education Department computer lab. Pedagogical concerns, particularly the need for teachers to become less the source of information and more the facilitator of learning, were also addressed. A one day workshop, funded through a grant written by one of the university team members, trained participants in locating and collecting primary and secondary source material. Designing appropriate formative and summative project evaluation forms proved to be the greatest challenge and consumed the greatest amount of planning and training time.

University student participants received initial training for the project in their respective methods courses, and their experiences are a part of the on-going dialogue as part of the early field program. Students also began going to a local coffee house after their weekly "day at the high school" to discuss and reflect on their experiences. This was an unexpected bonus of the project.

At the high school level, students learned about the project initially in their English and Social Studies classes where individual and group responsibilities were decided. Word processing skills had previously been developed through the English classes as a result of the project described above. Additional technological needs were addressed when students attended two workshops at the university focusing on databases, mail merges and labels. Students had the opportunity to experience a state-of-the-art computer lab, in a college setting, with workshops taught by university faculty members. Follow-up/practice sessions were conducted by the high school media specialist.

Reflections

At the midway point of the year-long project, participants are almost unanimous in their enthusiasm for the project. It has solidified an already positive relationship between university and high school faculties; it has also generated considerable interest in the history of the high school and its relationship to community and world events. Already the findings have been productive:

- teacher and administrative salaries since 1914;
- teacher's contracts, including one from 1910;
- school board minutes — minutes from 1913-14 reflect the same dilemma the present school board is facing, whether to remodel or rebuild the school;
- yearbooks from 1927;
- a list of almost every football player who has ever played for the school;
- diaries, including one kept by a student who graduated in 1905; and
- pictures of graduating classes with a star above the head of each graduate killed during World War II.

Students found irreplaceable history in deteriorating boxes confined to abandoned closets. As news of the project has spread, alumni have offered their contributions: letters, memorabilia, and memories.

The teachers, in turn, forged a closer working relationship with students, acquiring a greater sense of their talents, their pride in themselves and their sense of accomplishment. They also discovered the inevitable problems of intergroup relationships — overcoming personal problems and arriving at compromise. Working collaboratively with emeriti faculty and university interns, they learned about the impact of the past on the present.

Ambitions

In the semester that lies ahead, the participants will focus on shaping their research into a journal and multimedia presentation, both of which will tie the past to the present. Additional computer training will be required — teachers found that technology is indeed a key component in fostering a change in the traditional roles of teachers and students. Even special students infused into a regular classroom found themselves a part of the project because they learned, with the assistance of a college intern, the essential technological skills. Perhaps the greatest problem to be faced during the second semester, however, will be finding the time to sort, classify and organize the huge volume of collected information and memorabilia. The Senior Capstone Project has forged connections; information technology has served as a vehicle for restructuring curricula which, in turn, has restructured the roles of both teachers and students.

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Tech Camp: A Model Institute for Integration of Technology and Education

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In recent years, the proliferation of computers, software, and other technological tools in schools has not, in many cases, been supported with sufficient training on basic use or on how to apply the technology in the classroom. In Sioux Falls, South Dakota (a city of 110,000) for example, every public school teacher has within the last two years been supplied with a laptop computer in addition to technology-rich computer labs and classrooms—all loaded with the latest software. In all, the district's director of staff development estimates nearly 4,000 new computers are now ready to meet the needs of 18,000 public school students. Augustana College, a small liberal arts college in Sioux Falls, has been similarly aggressive in acquiring equipment, providing its 1700 students with some 500 computers and access to the Internet. Recognition by professors at Augustana and by staff development coordinators at the school district of the growing gap between technology availability and technology training and integration led to the creation of Tech Camp '94.

Tech Camp '94, a joint summer institute of Augustana College and the Sioux Falls school district, was the result of recognition of the gap between the technology available and the expertise to utilize it fully. An exciting week-long program of computer workshops for teachers, administrators, school staff, and college students, Tech Camp drew over 200 participants seeking the opportunity to learn about a wide variety of practical and engaging applications for technology in the classroom.

Tech Camp can be a model both for training teachers in the uses of technology and for collaboration between schools and higher education. Augustana College and the Sioux Falls school district worked closely together to meet the needs of classroom teachers and in the process built a strong network of technology-minded educators dedicated to improving education from kindergarten through college. Tech Camp tries to answer the question, asked by so many teachers, both in the schools and at the college level: "Okay, I have all this hardware and software. Now what can I really DO with it in my classroom?" The camp-like atmosphere facilitated an attitude of exploration, creativity and collaboration among teachers which reinforced much of what is so powerful about the potential of technology in the classroom—the sense of excitement, immediacy, connection and involvement it can create.

Tech Camp: The Concept

The concept behind Tech Camp was that teachers who had developed classroom applications of technology could share their courseware and train other teachers in its uses. So often in the computer workshops that Augustana and the school district both offered, was such a variety of aptitude and development in the teachers' skills. Though the district had provided laptop computers to *all* teachers (Macintosh Powerbooks to elementary and middle school teachers; IBM notebooks to the high school teachers), many had reached the limit of using the computer as a personal productivity tool, while a few had already developed uses for them in their classrooms. Some computer phobia was still present so not only training, but friendly persuasion as to the accessibility and ease of technology use was also in order. The idea for Tech Camp arose as a solution to this problem—an ironic one for educational institutions—how do you insure that education on technology's uses keeps pace with hardware/software advances and acquisitions?

Although Augustana is a liberal arts college, it has a strong education department, that has the largest number of majors on campus and long-established connections to the Sioux Falls School district. It also has small graduate programs in Secondary and Special Education, and runs teacher education workshops all year long. Sioux Falls teachers enjoy contracts that give salary recognition for continuing professional development through credit workshops and courses, and for graduate degrees. As the hardware/software started flowing into the district, demand for computer workshops soared. The district offers subsidized workshops, but on a limited basis. Augustana workshops draw participants from the overflow and by offering topics of special interest to teachers. As Augustana and the school district strove to meet the demand for computer workshops of all kinds, close communication became essential.

The Goals: Integration, Connection, Networking

Tech Camp—originally known as Technology Camp for Teachers—was born in a meeting between Augustana and Sioux Falls school district faculty and staff interested in providing teachers with opportunities to learn how to use the hardware and software they had been handed. The concern was not only to train them in the use of computer applications, but to help them to explore how to *integrate* technology into their classrooms. To achieve this goal, we decided that connecting teachers to teachers (at all levels, K-16) would be the most effective strategy. As we discussed the need, our conversation led to the idea of encouraging collaboration and networking (an idea clearly in keeping with technology and its transformative powers) between educators on the uses of technology. Indeed, Internet was recognized as the next "big" topic for K-12 educators, and we wanted to play upon the possibilities that such electronic connections between educators can create.

Networking occurred on all levels as the college and the district worked hand in hand to develop an appealing, engaging, high-tech, low-anxiety extravaganza of technology workshops and demonstrations. These were taught almost exclusively by Sioux Falls teachers and Augustana faculty, packed into one week in June, the prime month for teacher education in the summer. The district and the college were co-sponsors of Tech Camp, with strong leadership coming from both sides. Augustana was host, because the campus was conducive to a "camp" atmosphere. Food, facility, registration, and other logistical arrangements were made through the college. Subcommittees, consisting of district and college staff, planned the curriculum, located and engaged the teaching faculty, and were there to run the camp. The district provided about 100 new Macintoshes to create three additional labs on campus. Those computers were trucked, unpacked, networked, registered, and loaded with software by both college and district personnel.

Connections, collaborations and networking at all levels was what made tech camp so appealing and so effective. The relationships developed between the college and the district have enabled us to meet the needs of teachers in the district much more effectively. Through the close institutional and personal connections created by this collaboration, Augustana College gains firsthand knowledge of the needs of the Sioux Falls school district teachers and can bring its technological expertise and resources to bear in filling them. The relationship between the college's teacher education program and the district has been strengthened and we have discovered impressive technological resources and expertise in the K-12 teachers and district staff. Quite frankly, Tech Camp made the college ask some hard questions—and to take some action— about how to further the education of its own faculty on the uses of technology in higher education.

How Tech Camp Was Organized

Tech Camp was a week-long series of stand-alone workshops on a variety of technological applications, on both DOS and Macintosh platforms. Overall, forty-five workshops were offered. A sampling of topics includes: Introduction to Internet, Networks, HyperCard, ClarisWorks, Desktop Publishing (Mac and DOS in separate workshops), Sim City/Earth City, Disabilities and the Computer, Talking to the World Through the Modem, Ergonomics and Peripherals, JEDI Project using CD ROM, Music and the Computer, Multimedia, Story Writing and the Computer, Data Collection for the Science Lab, Electronic Books, Robotics and Lego Logo, Elementary Math Software, Electronic Libraries, and Graphing Calculations.

On their pre-registration form, participants indicated their choices for placement in the workshops offered, and the Tech Camp staff devised a schedule for them based on their individual interests and the overall demand for particular topics. Each participant, for a registration fee of $75, could take a full schedule of workshops, morning and afternoon, from Tuesday through Friday. Three meals and a T-shirt were included in the $75 fee. Registration and an opening kick-off session were held on Monday evening. The opening session provided not only camp procedures and credit requirements, but also multimedia presentations of outstanding teacher and student technology applications for the classroom.

Graduate credit was available through Augustana College, at a deeply discounted rate of $35 per credit hour, for up to two hours (26 contact hours plus a written project). Those interested in credit were put into groups based on their teaching areas and interests, and were charged to develop a project for their classrooms, using the technology training they had received at Tech Camp. Plans for these projects were presented during the last session of Tech Camp. Time to develop them was scheduled into the camp sessions.

Our Successes and Failures

Though we felt Tech Camp was, overall a great success, there were, naturally some things that we weren't so enthusiastic about—things we'll definitely change. We armed ourselves with determination and a sense of humor, especially regarding our own failures and oversights. Our successes, we celebrated.

Successes

Tech Camp drew 200 participants, so we knew we had a "market" and an attractive concept. On the last day of the camp, participants filled out a program evaluation. Results were extremely positive for the camp as a whole, and often called for "more of the same." Participants were pleased with the atmosphere, the curriculum, and the overall organization of the camp. The camp atmosphere was created with picnic meals on the green, Tech Camp T-shirts (very popular), and a relaxed attitude, which promoted creativity and esprit de corps while neutralizing technology phobia. The fact that many of the instructors were school district teachers and Augustana professors, rather than imported "outside experts," underlined the fact that we have much technology expertise in the area, that using technology is not an esoteric art practiced only by technocrats, but rather a powerful tool accessible to all who have a willingness to learn. Creativity and collaboration,were very much apparent at Tech Camp. One group of teachers, for example, was so excited by the experience, that they stayed overtime to produce a multimedia presentation on Tech Camp—based on a Star Trek theme-with themselves as the crew of the Enterprise, exploring "strange new worlds."

The Tech Camp logo, produced, of course, on the computer was important in establishing a visual identity for the program. The logo depicts gears and cogs in abstract design in the background, with the capital letters T and C in the foreground. The logos of Augustana College and the Sioux Falls school district were prominently displayed beneath the logo, indicating our collaborative effort. We used the Tech Camp logo on all of our correspondence and advertising, as well as on all camp materials—notebooks, signs, etc. Tech Camp has become a well-known entity with the area teachers after just one year, and we believe the attention to graphic design and quality (made possible largely by technology) has been an important contributing factor to that.

Technical support was critical. All hardware and software had to be up and ready, and maintained in top working condition at all times. Personnel from both the college and the district were always on hand to keep the hardware and software in perfect working order. Logistical snafus can easily snuff creativity in the classroom.

One very important final lesson: the T-shirts are mandatory. Participants love them, they help create camaraderie, and they give the program identity and a presence in the community.

Failures

Negative comments were about isolated or relatively trivial, repairable items: an evening meeting (they preferred all daytime scheduling in the summer), a poor meal, one or two instructors who did not run interactive, hands-on sessions but instead lectured and were not responsive to the class.

One important item: we didn't charge enough. Our price was very attractive, but we probably gave too much for what we charged. Tech Camp just barely broke even, when we had hoped to make a modest profit to invest in further technology, and as seed money for Tech Camp '95. We want to keep the price low, but will probably look for grant support to do so.

Tech Camp '95—Or, How to Learn from Our Successes and Failures

Having run a program once, you develop a feel for how it will go next time. The first time is an adventure into strange new worlds, not just for the participants, but for the organizers. Everything has to be invented at once. It is our hope that this paper provides some of the wisdom gained from our experience and preclude the necessity of having to "reinvent the wheel" in designing a program to fit your situation and your needs for technology training.

What our participants wanted and needed,were hands-on, practical, interactive workshop experiences. They responded best to instructors who were facilitators, mentors, and patient guides in their explorations of new technologies, and worst to those who lectured and failed to respond to the needs and interests of the class. Furthermore, once participants master the first steps, they almost always want to go on. The calls for more advanced workshops on some of the introductory topics were numerous. Teachers were also very interested in time for guided practice and the chance to be creative—with troubleshooters available for problem solving. In other words, teachers are looking for—and Tech Camp provided—all those things which we most value in education today: interactive learning strategies, attention to individual learning styles and goals, facilitation of collaborative efforts, and empowerment of the learner. What many of the teachers learned, and what was reinforced for us, was how readily technology adapts to and enhances these learning processes—how very human and humane a tool it is after all, and how very adaptable to education.

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Information Technology in the Classroom: A Model Approach

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The Center for Education and Training in Technology

We have come a long way in Alabama from the days when women held their suffrage meetings in Mobile, when Montgomery's children rode pony carts, and when gentlemen on horseback illuminated Birmingham's historic district by hand lighting 50 gas lamps each evening. Even though Alabama has made great progress, many Alabamians have become aware that an enormous need still exits in educating our young people. It has become clear that Alabama, like many other states, failed to ensure that all segments of the population participate in the education process on an equal basis.

Today, education reform is a top priority. Information gathered from across the nation points to technology as a way to achieve equitable, high performance education. Once the common denominator for an approach was identified, further investigation revealed that nation-wide, teachers were saying that they had no place to go to get the technology training that they needed to use in their classrooms. Many teachers had the hardware and the software but were not trained to integrate information technology into their curriculum. For educators, just like the business community and the general public, *time* seemed to be the currency of the 1990's. How could these teachers get "up to speed" in a short period of time? In addition, there were very few funds for inservicing teachers in their districts. How could teachers get what they wanted in a cost effective way? When probed further, teachers said that it was discouraging that they were never included in the decision making process that shaped the future of education.

To solve the problems, there was a look at the history, at the needs assessment, and at the approaches to these issues. After taking some creative problem-solving steps it was clear that creating The Center for the Education and Training in Technology (CETT) was the answer. CETT has interactive classrooms of the future with state-of-the-art equipment. It is a place that provides comprehensive hands-on instruction and support to educators. Since the success of today's classrooms depends upon the appropriate use of information technology, our center's participating teachers return to their districts as local trainers for other teachers. Graduates of our courses stay linked to the Center and use us as an on-going source for information, advice, and training. This gives our participating educators the opportunity to assist in the process of changing education by meeting the current needs of their students and serving on our steering committee.

In 1995, both students and teachers will learn through a global community network with electronic field trips, sharing of cultural information, expanding curriculum, educating remote areas. . .the opportunities are limitless. The Center for Education and Training in Technology (CETT) will serve as a working model and demonstration site for these networks and for the integration of education, training and technology. The following features of CETT will help schools and the teachers access the on-ramp of the information highway. These features include:

- linking with teacher inservice centers across the state;

- offering a full range of interactive, hands-on informational technology courses;
- offering consulting for training of the future workforce;
- exhibiting and testing in our Technology Demonstration Area;
- providing grant writing seminars for education projects;
- linking with places focused on specific content areas such as: science centers, museums, and libraries; and
- furnishing current and unbiased information regarding technology selection criteria, uses of technology and the appropriate applications of technology in the classroom.

We have created a model where the educational community benefits in numerous ways. Key benefits include:

- transformation of curriculum and instruction to fit the information age,
- increased productivity for educators and administrators,
- appropriate selection and use of equipment and application for various settings,
- integration of informational technology in the process of educational change,
- on-going academic and technical support, and
- access to evolving technologies and applications.

CETT's Q & A

Q. *Teachers*: "How can we afford the teacher training in technology we need, when our district's budget is being cut?"

A. CETT has discovered that helping schools with their grantsmanship fills a need for many educators. Teachers are very creative and their creativity has served them well by "thinking outside of the box". In addition to writing successful traditional grants, many teachers have succeeded by writing a "pooled" grant with a neighboring district, by writing interdisciplinary grants (i.e., arts and reading, math and science), or writing the costs of quality unbiased consulting into their grant's budget.

Q. *Teachers*: "What else can we do besides grant writing? We do not want to put all of our eggs in one basket in case our grant is not funded."

A. School/business partnerships have also proven useful to many of the schools we work with at CETT. We inform businesses and schools as to the process involved in establishing an effective partnership. An exciting example of this is CETT's Adopt-A-Teacher program that is being well received in our community. This is a program where specific businesses have precommitted to sponsoring a teacher for technology training. If selected, the "adopted teacher" receives useful technology training, a paid substitute for the duration of the training, and transportation/meal expenses. The teachers selected for this program not only return well trained, but return as a trainers who are prepared to teach others.

Q. *Principals*: "I sent 21 teachers to technology training and only one out of three are implementing what they learned. How can I increase the application of training into the classrooms?"

A. The teachers we work with say an easy-to-use, readily available, trouble shooting source of assistance is what they need following training. As a response to this, CETT provides an on-going technology and application support network. Using educators as trainers is another way to increase the probability of training transferring into the classroom. Teachers already do that daily with their own students and are masters at skill application.

Q. *Parents*: "How do we level the playing field, for all parties involved in education, for our state?"

A. Two good starting places are distance education and learning to link. Help your child's district investigate distance education. By way of definition, distance education refers to instruction that originates at one site, distant from the learners. It can involve two-way communication by means of an interactive audio and video component. See if this technology would be beneficial to your district. Secondly, investigate ways your district can "learn to link". There are numerous ways your schools can link to the superhighway of information and you can quickly become experts at accessing current, accurate, useful material. We are finding more and more parent volunteerism in the area of technology. Some volunteer time in a school's computer lab; others assist students on computers in classrooms; and others assist with the planning, searching, previewing, and purchasing of instrumental software for a classroom. Schools are willing to train parents in a specific need area, and parents are often eager learners.

Q. *Teachers*: "How can I use what I learn in technology training when I have very little technology available at my school?"

A. The answer is to do a good job implementing what you have just learned with the technology you have, even if that is merely a VCR and an old television set, or one computer you share with another teacher. Get started integrating technology into your curriculum, and from there continue to build. If you do not have any available technology for your classroom, be a technology cheerleader with your PTA and see if they will help you get started.

Q. *Technology Specialists*: "Should the teachers in our school district be concerned with the changing role of the teacher due to technology?"

A. For one thing, teachers are often concerned that technology will replace them in the classroom. This is not true. Good teachers will always make a difference in quality education. For some teachers, technologically advanced classrooms will help them expand their repertoire of methods and materials, as well as move towards more student-centered classrooms. The teachers will always remain the most important component in learning. Teachers are now learning how to use technology as a flexible tool that fits their teaching styles and meets the needs of their students. CETT's intention is not to add on to teachers' responsibilities, but to supplement and support their efforts.

At The Center for Education and Training in Technology, we have found that technology training increases teacher effectiveness, empowers students, provides a wealth of information to a school, and improves inservice educa-

466

tion. CETT is a model for others who would like to provide comprehensive technology instruction and support to the educational community, promote understanding and utilization of technology, and encourage appropriate applications of various technologies.

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One Teacher Education Program's Answer to Technology Integration

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Northern Michigan University (NMU) is under fire from the state legislature, the State Department of Education, and the National Council for Accreditation of Teacher Education (NCATE) to prepare teachers for the use of technology in their future classrooms. Guidelines abound from these and other agencies concerning the goals of such preparation. To facilitate the incorporation of these technology goals into the preservice and inservice teacher education programs, Northern Michigan University appointed a Technology and Teacher Education Committee. The charge to the Committee was to develop a plan that would include:

1. technology competencies that every preschool, elementary, middle, and high school teacher should have;
2. technology competencies that every Education Unit faculty member should have and a committee-recommended training program to achieve those outcomes;
3. requirements of school districts and universities for supporting these competencies;
4. guidelines for preservice and inservice curriculum;
5. guidelines for measuring the performance of Education Unit faculty in achieving the technology outcomes;
6. recommendations for the implementation of the plan, including resources needed and an implementation timeline; and
7. provision for ongoing evaluation.

Charge 1 and the first portions of 2 and 3 have been completed as of this date. Work on the remaining charges will be completed this academic year ('94-'95) and will be reported more completely at the SITE95 conference. This paper will outline the steps to date and results with the intention of providing a model for the integration of technology into other teacher education programs.

Technology and Teacher Education Committee

The Technology and Teacher Education Committee developed a mission statement for the Department regarding educational technology. The mission statement has been approved by the Department and is scheduled to be reviewed by the Professional Education Council. This document, parts of which follow, acts as a guide throughout the integration process.

Mission Statement

The mission statement begins with an overview of the importance of technology to society as a whole, including business, industry, the government, and of course, education. Yet a 1993 study of preservice experiences and classroom computer use of recent college graduates (Topp, Thompson, and Schmidt, 1994) highlights the fact that over 67% of the respondents felt their preparation for using educational computer-related technologies was less than adequate. As stated in NMU's mission statement, "the question facing educators, particularly those of us preparing future teachers, is not whether technology will be employed in the schools, but when, how, and for what purposes."

The Committee reviewed various position papers and documents related to the state of educational technology in today's schools. The information tends to recognize the enormous pace of change regarding hardware systems and programs. It is critical to note that the process of instruction is, itself, a technology. This process or system provides a goal-designed sequence that is based on observable indicators and outcomes. Most communication and information systems incorporate voice, video, and data that are applied in learning stations, labs, or classrooms. The merging of computers, information, and video forces new ways of looking at educational media.

In reviewing relevant references it became apparent that people incorporate tools in problem solving, communications, and information applications, and schools will change as a result of technology. Several agency guidelines that were critical in the plan are listed below.

NCATE Technology Recommendations

All candidates seeking initial teacher certification or additional endorsements should receive foundations that prepare them to:

1. demonstrate ability to operate a computer system in order to successfully utilize software;
2. evaluate and use computers and related technologies to support the instructional process;
3. apply current instructional principals, research, and appropriate assessment practices to the use of computers and related technologies;
4. explore, evaluate, and use computer or technology-based materials, including application, educational software, and associated documentation;
5. demonstrate knowledge of uses of computers for problem solving, data collection, information management, communications, presentations, and decision-making;
6. design and develop student learning activities that integrate computers and technology for a variety of student grouping strategies and for diverse student populations;
7. evaluate, select, and integrate computer or technology-based instruction in the curriculum of one's subject area(s) and/or grade levels;
8. demonstrate skill in uses of multimedia, hypermedia, and telecommunications to support instruction;
9. demonstrate skill in using productivity tools for professional and personal use, including word processing, database, spreadsheet, and print or graphic utilities;
10. demonstrate knowledge of equity, ethical, legal, and human issues of computing and technology use as they relate to society and model appropriate behavior;
11. identify resources for staying current in applications of computing and related technologies in education;
12. use computer-based technologies to access information to enhance personal and professional productivity; and
13. apply computers and related technologies to facilitate emerging roles of the learner and the educator.

Standards in specialty content areas should include experiences with:

1. general concepts and skills, i.e., uses of computers in society, terminology, historical developments, social and ethical concerns, equity issues, professional development opportunities, student support activities, and the learning of keyboarding skills;
2. programming and problem solving;
3. application tools;
4. information access and delivery tools;
5. hardware and software selection, installation, and maintenance; and
6. professional teaching preparation, including knowledge of and experience with teaching methodologies relating specifically to instruction about computers and related technologies.

Michigan State Technology Task Force Guidelines

In addition, the Michigan State Technology Task Force made the following recommendations.

Restructuring Schools Using Technology.

1. Each education institution must recognize the new technological skills needed by current and future workers, as well as the information skills required by a literate, educated citizenry.
2. Technology must be viewed as critical to school reform and educational institutions should support the utilization of technology to assist in restructuring the instructional process.
3. Each education institution in Michigan should engage in strategic planning on a local and regional basis for the utilization of technology in learning, teaching, and communication.
4. Policymakers should include preschool, K-12 education, postsecondary, and adult education populations, where appropriate, when planning technological systems and services.
5. Schools must integrate technology throughout the curriculum and should develop a technology education curriculum.
6. Appropriate technologies to meet the specialized need of individuals with disabilities must be made available.

Statewide Systems for Teaching, Learning, and Communication.

7. Access to information, communication, and broadcast services must be affordable for educational institutions.
8. A statewide telecommunications system, with a gateway for voice, video, and data, must be accessible by all citizens and educational institutions.
9. A system of governance for educational telecommunications that is inter-agency and inter-sector should be established.
10. Ongoing dialogue must occur among the educational agencies and professional organizations concerned with the expansion of statewide services and systems.

11. A computer network should be established that is accessible by all educational institutions, including K-12 classroom teachers.
12. Technological applications should be supported for administrative and management uses.
13. School-home communications should be improved through technological systems such as voice mail, computer-based telecommunications, and instructional television programming.

Professional Development for the Learning Community.

14. Professional development programs must be provided to ensure the technological competence of preservice teachers and to upgrade the technological skills of teachers, administrators, ancillary staff, parents, community members, and local boards of education.
15. Incentives should be provided to teachers, administrators and students to demonstrate, investigate, evaluate, and apply technological systems.

Technology Investments for the Future.

16. Educators and administrators should be informed about technologies available to educational institutions at little or no direct cost.
17. An assessment of educational agencies' financial ability to establish technological systems should be conducted and options for stable funding of institutionalized state technology services must be investigated.
18. Facilities renovation and construction standards should be developed with minimum specifications for the design of technologically-rich learning environments.
19. At a minimum, every building at an educational institution, including teacher preparation programs, should be equipped with a computer network, fiber optics, cable access, and a dual-band, steerable satellite dish.
20. At a minimum, every classroom at an educational institution, including teacher preparation programs, should be equipped with a telephone line, computer, videodisc player, videocassette recorder, and television monitor.
21. At a minimum, the state's library media centers and programs should be equipped with the same technology tools as a classroom, incorporating automated circulation and card catalog systems.

Copyright and Fair Use.

22. Educational agencies should be informed about the copyright law and monitor their use of copyrighted materials to ensure compliance with the law.

Michigan's Public Act 335

During the 1993 legislative session, Public Act 335 was enacted further identifying the importance of technological preparation for teacher education students. Specifically, the act requires as of July 1995 that in order to participate in student teaching, teacher education students in Michigan will need to demonstrate their ability to utilize educational technologies. In response to this mandate, a Quality Assurance Statement was drafted and approved by the Department of Education at NMU. This statement included a reference insuring that our students "have working knowledge of modern technology and use of computers" prior to their student teaching experience.

Technological Competencies for Preschool, K-12, and Teacher Education Faculty

Technological competencies for teacher education faculty flow from the competencies required by teachers of K-12 students which, in turn, flow from the competencies desired for all students as well as being guided by the above listed agency guidelines. Niess (1991) outlined a list of competencies for computer using educators in her article, "Preparing Teachers for the 1990's". From the Niess's list, the Technology & Teacher Education Committee developed a list of competencies for teacher education faculty that are considered necessary to develop the competencies required for preschool and K-12 teachers. Every faculty member is a teacher educator. Teachers teach as they were taught much more than as they were taught to teach. Therefore, it is critical to assure that all students, including future teachers, learn English, mathematics, science, and the humanities at Northern Michigan University in the way that teachers should teach. Hence, the staff development need extends beyond the "official" Education Unit faculty.

Every teacher educator is expected to:

1. use technology, both hardware and software, as personal and professional tools. This includes using programs such as word processors, data bases, spreadsheets, grade managers, graphing programs, test generators, presentation programs, e-mail, and telecommunications in the execution of their personal and professional duties including professional development, teaching, research, and service.
2. integrate technology into the curriculum rather than fit the curriculum to the technology. At the same time, teacher educators should not limit technology's use to the current curriculum, but be ready and willing to adapt the curriculum to new needs of a technologically, information-based society. The curriculum will change in some very fundamental ways and we must be critical in our judgments and flexible in our decisions regarding the curriculum. Risk-taking will be essential.
3. uphold copyright laws in the use of all materials and require the same of students in their classes.
4. discuss the advantages, disadvantages, and implications of technology in the school, home, and society in general, including social and ethical issues.
5. use technology in the delivery of course materials, thereby modeling technological uses and applications, including, multimedia, simulations, CD-ROM, databases, hypermedia, and telecommunications in a variety of teaching/learning situations.
6. "troubleshoot" minor technological difficulties.
7. communicate orally and in writing using appropriate technological terminology and tools.

8. be eager to experiment and integrate new educational technologies as they develop, facilitating the emergence of new roles for the learner and the educator.

Institutional Supports for Technology

In order for preschool-12 teachers and teacher education faculty to execute the competencies as outlined above, it is crucial that local school districts and universities providing teacher education accept the responsibility to support these efforts. To do so requires every school district and teacher education institution to:

1. supply teachers and classrooms with the appropriate hardware and software to accomplish these goals;
2. provide access to the electronic highways of the world;
3. plan for the maintenance and continual updating of both hardware and software; and
4. support teachers and faculty through providing continual professional development and training in the area of educational technologies.

Stages of Implementation

Initially, it was necessary to ascertain the state of educational technology in the Professional Education Unit at NMU. This entailed a person-to-person interview of the faculty to determine each member's level of experience and expertise relating to educational technology as well as what they might be interested in developing for their own professional work and use in their classes. Some members, because of their expertise, were identified as resources in aiding others. Hardware and software available to the education faculty in their offices and classrooms was also identified at this time. This assessment of the faculty, hardware, and software was necessary in order to know what needed to be accomplished. The initiatives discussed in this report were a direct outgrowth of this initial assessment process.

The individual interviews identified faculty members at quite diverse stages of knowledge, some with no computer experience at all and others very knowledgeable in some aspects of educational technology. Therefore, upon completion of the interviews, the author worked individually and in small groups with the faculty on areas of need and interest.

As a result of this initial assessment of the state of educational technology in the Professional Education Unit, initiatives were started that would add to the availability of hardware and software and in increase the expertise of the faculty members (human resources). The amount and diversity of educational software for use by the education unit faculty in their courses was scant and out-dated. To help alleviate this problem, letters were sent to educational software publishers asking for donations to the Media Center at the Olson Library to be made available to the education faculty, the pre-service teachers in the education program, and to in-service teachers in the area. This initiative resulted in approximately $10,000 worth of software being donated. In addition, a few publishers, i.e. Broderbund, chose NMU's media center as a software preview center. As a software preview center, the media center receives new software products as the publisher produces them, without cost or obligation. This initiative has added breadth and depth to the educational software available but much still needs to be done in this area. As donations, publishers sent their choice of materials. The acquisition of a variety and appropriate software remains a priority in order to demonstrate more of the unique features of educational computing.

It was determined there was a decided lack of the newer hardware technologies for use by the unit. The computers in the media center were primarily Apple IIs. The author applied for and received a Learning Technologies Fee grant from the University in the amount of $15,000 for the purchase of leading edge educational technologies for placement in the media center. These items included a Power Mac and a 486 DOS machine, both equipped with full multimedia capabilities including CD-ROM players, adaptive keyboards for special students, a graphics tablet, a touch screen, microcomputer based laboratory science equipment, an interactive chalkboard, a color flatbed scanner and a color ink-jet printer. Without adequate hardware and software, all the training of faculty in the use of instructional technologies would be futile. Therefore, a great deal of effort was expended in the initial year of the project attempting to provide both hardware and software. Additional hardware and a full state of the art educational technology classroom are foreseen as necessities in the near future.

As part of this initiative, ED 483, Educational Media, has been under revision by the author. This course was on the books but had not been offered for several semesters and needed reactivation and development to incorporate the newer educational media/technologies. The author has updated the outline and syllabus for ED 483, Educational Media, and offered this course as an elective to both graduate and undergraduate students in the Spring/Summer '94 session, the Fall '94 session, and is offering it again for the coming Winter '95 semester. For a complete copy of the revised outline and syllabus, please contact the author.

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Lorana A. Jinkerson is Assistant Professor of Educational Technology, Department of Education, Northern Michigan University, 125 Magers Hall, Marquette, MI 49855 Phone: 906-227-2159, e-mail: ljinkers@nmu.eduGrowing Our Own; Database Tending in Colleges of Education

Growing Our Own: Database Tending in Colleges of Education

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At a recent American Association of Colleges for Teacher Education/National Council for Accredtiation of Teacher Education (AACTE/NCATE) training session in Washington, DC, a major section was devoted to the importance of databases for teacher education. The address which initiated this section was one of the first presented at a major meeting of a general teacher education association to recognize the importance of databases for teacher education programs. The developer of this section, David Smith, Dean of the College of Education at the University of Florida, pointed out that all teacher educators have multiple, continuing demands for data-based information, and that the development of databases should be a priority for all teacher education programs seeking NCATE accreditation (AACTE/NCATE, 1994).

Roadblocks to Widespread Database Use in Teacher Education

Teacher Educators have been slow to recognize database management as an important component in information technology. For example, out of over 195 papers listed in the 1994 Technology and Teacher Education Annual (AACE, 1994), not a single title pertained to database development and management. In contrast, there is a very active literature in the business and personal computing press (Schroeder, 1990, 1994). In fact, a recent Computerworld editorial entitled "Unshackling corporate data," suggested that the commercial sector has gone *beyond* simply worrying about databases, and has entered a period when users want more than simple task-oriented data. They want "information that reflects the underlying patterns of the business, the thing invisible at the surface, but discernible within the strata of data" (Babcock,1994). Leilani Allen, head of Information Services at PNC Mortgage Corp. agrees. She says that what counts is building and maintaining the *core* of data and developing flexible technology infrastructures which will allow decision makers to get at and use the data to support rapid market-driven change (Garner, 1994).

Unfortunately, a roadblock to the widespread use of comprehensive databases in teacher education is a lack of general understanding of what database development entails. Many times the author has attended group meetings where database development was described, and typically the active attention of the majority of the audience started to wane as soon as discussion of the technical aspects of databases began. Although understandable, ignorance of fundamental database concepts within the teacher education community greatly inhibits the development of databases and their use for program design, management, and evaluation.

Basic Database Concepts for Teacher Educators

The Problem of Data

Accompanying the explosive growth of personal computers in teacher education, there have been dramatic gains in the use of productivity software, i.e., word processors, spreadsheets, and file managers. Most program offices now use computer-based file managers to keep track of membership lists and addresses, to engage in automated mailings and mail-merges, and to track student progress. Most commonly, these database applications weld together the data, the program used to store and retrieve it, and the specific programmatic functions the data is intended to service. For program managers, single-job database management is direct, easy to understand and manage, and relatively inexpensive to use. Unfortunately, from a database point of view, file management systems like this make organizing and accessing data across programs difficult or impossible. Everest (1986) identifies this as *the problem of data*. He says that it is the "Sharing (of) data among applications and (the) transferring (of) data across machines and systems (which) creates data problems" (pp. 6-8). Continuing, Everest suggests that a byproduct of *the problem of data* is that "as... investment in... data increases, (there is an accompanying increase in) the cost of shifting to new machines and to new technology, and of incorporating new application systems" (pp. 6-8). In other words, as colleges attempt to marshal large, diverse sets of data, correcting the lack of integration between data bases used in individual departments and offices will become increasingly expensive. Martin (1991) helps to explain these looming costs by suggesting that there are three problems with the traditional, single-job database approach. First, there is a *high level of data redundancy*. The same data, usually in slightly different formats and stages of currency, is stored in many places throughout the organization. This means that personnel resources must be expended to manage what is essentially the same data in each office that needs it. Second, there is a *high degree of inflexibility*. Because the formats, database programs, and groupings of data are different, "ad hoc queries from a user employing a generalized query language cannot be answered." That is, a manager cannot have a simple question answered, even though the data to answer the question resides in different parts of the college. Third, there is a *high level of expense associated with changes in files across the overall program*. Because of the first two problems, Martin suggests that even "a seemingly trivial change in a file environment sets off a chain reaction of other changes...," because specific, individual changes have to be made throughout the many different discrete file systems in the organization, to bring them all in line with organization-wide changes or needs (pp. 8-10).

The Relational Model

Within the past decade, many institutions have attempted to overcome these deficiencies by adopting relational database systems. Plain (1994) indicates that "the relational database is founded on a relational data model, a theoretical model invented by Edgar Codd, a mathematician at IBM over 20 years ago. The concept was so revolutionary and controversial to database design that it took a dozen years before it was even implemented by IBM" (pp. 612-617). Everest (1986) compares the shift that occurred in thinking about data with the Copernican revolution. He says, "Just as Copernicus argued that people's conception of the center of the solar system must shift from the earth to the sun, so our view of data processing must shift from programs to data. Just as the earth draws upon the resources of the sun, so do programs and people draw upon the resources of the database." (pp. 4-6) A relational database is intended to make data independent, usable in many ways across a multitude of specific programs. It does this by specifying rules which must be followed throughout the organization when developing database files. (Pratt and Adamski, 1987)

Unfortunately, although the concept of a related set of databases is easy to grasp, it is hard to envision. The perception of the database user is restricted by the use to which specific data items are being put. The user does not perceive the entire database, only those specific data items which have been selected to accomplish his or her particular function. In actuality, according to Martin (1991), "A database is a collection of data which are shared and used for multiple purposes. Any one user does not perceive all of the types of data in the data base, but only those that that are needed for his or her job. A user may perhaps perceive only one file of data. That file always has the same structure and appears simple, but in fact it is derived from a much more complex data structure" (pp. 2-4).

In summary, it is clear that multipurpose databases are becoming more important to colleges of education. To clarify the nature of database development, examples of actual database development are required.

An Example of Database Development in a College of Education

Early Years

Early database development efforts in the Murray State University College of Education (MSU/COE) were directly tied to managing the admission to teacher education process. The first database developed for this purpose was a single, long, complex file which included all necessary information about each student, including demographic information, majors, advisors, grade point averages, admission status, basic skills test results, ACT scores, etc. Data was first entered into an AppleII file management program which also allowed for the development of custom reports. The single-purpose file structure, however, welded the Admission database file to the logic of the admission to teacher education process. With the growing popularity of the IBM Personal Computer, the decision was made to change computer platforms so as to take advantage of Dbase 3+ (at that time a new relational database management program), and R&R Report Writer, a program which allowed for the easy development of reports and letters using data from multiple Dbase3+ database files. It was thought that a more flexible file system would facilitate the sharing of information by staff members. Software program manuals, third party instruction manuals, and database management periodicals were the primary source of theoretical information for how a database should evolve and how a data center should be operated. Backup software was purchased and used to protect data, and a coding manual was developed to facilitate standardization of data entry and maintenance.

The use of the Admissions database file to facilitate program management was a minor revolution. It opened eyes as to the potential inherent in database use, and encouraged the establishment of two additional files; one for tracking CTBS basic skills testing information, and the other for tracking student performance on the NTE state certification qualifying exams. These two new files were the first opportunity to practice relational data modeling. The CTBS file was a halting effort. It shared common problems with the Admissions file. It was overly long and welded too tightly to the logic of the admissions process. When the file had been implemented and its inflexible nature became clearer, the problem of altering database structures on the fly also became evident. However, these experiences positively influenced the creation of the NTE tracking file. For example, it was much shorter and individual entries were tied to discrete administrations of the NTE tests, rather than to a large cumulative record for each student. The structure of the file was more abstract, and thus more independent of the admissions process.

Early database development efforts in the MSU/COE were closely tied to the admission to teacher education process. As experience was gained with databases, there was a conceptual shift to view the database as a separate resource, independent of the admissions to teacher education program. As new database files were developed and related to the older ones, it was possible to note how the flawed structures of the older files limited the power of the emerging total database. However, by having standardized all files on a single type (Xbase), and by adhering to a consistent relational data management system, it was possible to make progress in pursuing the relational database model.

Phase Two

Phase Two in development of the MSU/COE database centered on managing the *pre-student teaching participation field-based activities program*. Procedurally intensive and growing with the expanding MSU student body, this program was an ideal candidate for database support. Building on earlier experience, the database development staff was able to conceptualize four new database files as a relational group. A map of potential database relations (including some items from the older Admission file) was generated, and efforts were made to reduce data item duplication (redundancy) where ever possible. The four new files were: 1) *a file of special information about students* to be shared with public school teachers; 2) a placement file, with specific information about the locations, dates, and times for each placement, organized by student; 3) a file of all placement courses, including salient information about each; and 4) a semester and course section file which allowed tracking of each section of each placement course, each semester.

These files were used to generate the paperwork necessary to manage large numbers of students in a limited number of schools. Accuracy and timeliness of reporting was critical. In the past, when single purpose files were used to manage programs, the structure of the database file so closely paralleled the functions being managed that understanding how the file was to be used was relatively easy. In the relational system, however, where multiple files were accessed to produce the necessary data items, the database management system became more abstract and "technical," thus requiring a greater understanding of electronic database systems for confident use.

Phase Two brought the staff eye to eye with the strengths and requirements of an integrated database system. It taught them that such a system clearly was capable of managing a complex field placement operation. On the other hand, database management procedures which had once been "experimental" now became mission-critical, and all staff members had to confront the idiosyncrasies of hardware and software. Database management procedures required a different time schedule, a different way of allocating personnel resources, a different, higher priority for database maintenance activities, and an increased importance for interdependence between staff members. Program management in conjunction with a database center became as important as the development of the database.

Phase 3: Data Integration and Address Files Development

During Phase Two, there were increased opportunities to use data files for purposes independent of the specific teacher education functions that they had been designed to service. For example, data from the participation files were used to a greater extent in managing the admission to teacher education process. In addition, it became clearer that where earlier data files had primarily been used to track students in the program, there was emerging a need to track the program itself, particularly the people who operated it and the public schools that supported it.

There had always been an address file. In its earliest iterations, it was maintained so that mailings to faculty and public school personnel could conveniently take place. This limited-use file was long, overly complex, difficult to maintain and not easily usable across programs. In Phase Three, the problem of more fully accounting for all aspects of the teacher education program, including students, faculty, field sites, courses, and addresses needed to be confronted. It was decided to create a group of related files loosely organized around the concept of professional educators working with the teacher education program. The old address file was subdivided into five new files. These included: 1) a professional identifier file, including such items as social security number, sex/ethnic codes, and a unique identifier number; 2) a professional role file which allowed tracking of the various aspects of the teacher education program in which an individual participated; 3) an MSU/COE professional employment data file, 4) a home address file, and 5) a file of all schools, institutions and departments with which professional faculty or staff might be associated.

During Phase Three, database management efforts definitely shifted to files which were constructed to be easily usable across program elements. In Phase Three, database maps and matrices became critically important, because in order for the database items to be accessible, users had to know how the database was organized and how the various files could be related. Up-to-date coding manuals had to be maintained so that current codes would be readily available.

Summary of the MSU/COE Experience, 1982-present

Over the years the MSU College of Education database has become increasingly complex and capable of supplying data items across program elements. The database has developed sequentially, however, and new and old data files exist together at different levels of elegance and independence. The capabilities of the database management system have paralleled the increasing sophistication of the software and hardware available for database management. Current versions of the database managers in use are far easier to use, quicker, and more powerful than they were six years ago. College databases are much more important for managing program elements than they were initially. This has forced a rethinking of roles, responsibilities and resources necessary to operate the college data center.

Suggestions to Teacher Educators Based on Experience and Theory

Because database development is such a long range, open-ended undertaking, there are no pat formulas to guide the development process. However, several sets of suggestions would be helpful when considering a commitment to multi-purpose databases.

Remember David Smith's Characteristics of Effective Data Base Systems

Smith (1994) suggested five characteristics of an effective database system:

1) it should be a carefully designed and functional system for collecting, maintaining and analyzing data;
2) the system must have the flexibility to serve multiple purposes;
3) the system must be incorporated into the regular operation (of the college of education);
4) the system must be capable of easy modification; and
5) the database must be capable of supporting a rapid response.

Plan for Real (Not Theoretical) Program Activities

Database development is so time, money, and work intensive that there need to be real payoffs to sustain commitment. Databases should permit faculty and staff to work smarter, with greater rewards for the effort. As a result, initial database development should be focused on program areas with the greatest need.

Adhere to the Relational Database Model and Avoid Quick-fix Files

Focusing on immediate needs only will work if sufficient planning has been done so that as database files are developed they can be related together. Quick-fix files are those temporary files needed just this semester to do an emergency job. Quick-fix files usually don't fit the relational model, because they are inevitably tied to the logic of the program being serviced. Also, no file is ever temporary.

Fix Responsibility and Authority for Enforcing Database Design Rules

By definition, a database that is useful draws on information from across the college. Therefore, database files across the college must adhere to agreed upon design rules. This may mean yet another committee to establish what the rules are. It definitely means that a person with adequate authority to convene committees and promote committee efforts must be identified with responsibility for college database development.

Take the Long View, But Seek Immediate Products

Developing a useful, effective multi-purpose database will take years. A strategic plan is critical to establish a sense of direction and identify indicators of success. However, because errors and missteps cost time and effort, tactical planning is also important. To overcome resistance and apathy, identifying and publicizing regular success stories will make a difference.

Movement to the use of comprehensive databases in colleges of education has the potential to change everything. Everest's (1986) evocation of the Copernican Revolution metaphor, in retrospect, was on target, at least in the world of business. Leaders in teacher education are forecasting that this revolution is now overtaking teacher education. To be ready, individual colleges of education must begin the long, complicated process of building comprehensive databases as soon as possible.

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Publishing Partners: A University/School Collaboration to Publish a Technology Text

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Opportunities exist for university education professors and teachers in the schools to work together in endeavors that impact both the K-12 and the university settings, such as research, curriculum development, and preparation of materials for preservice and inservice teachers. In such collaborations each member of a university/practitioner collaboration can bring experiences and perspectives that may uniquely contribute to such projects. The practical day-to-day perspective that may be brought to a project by a teacher is invaluable. When combined with the conceptual perspective a professor might offer, the collaboration can produce an effective and worthwhile result. (Although teachers certainly can offer conceptual insights and professors can offer practical solutions, the intent of such collaborations is to bring the strengths of each member to the project.) This paper provides an overview of such a collaboration to publish two versions of a technology text to be used in preservice and inservice teacher training.

Collaborators

The collaborators in this publishing project each had many years of varied educational and computing experiences. The project began with the ideas of a university professor who had taught computer education courses and who had previously written other texts. He wanted to create a practical introductory computer text for preservice and inservice teachers that contained conceptual information and tutorial chapters that covered popular software packages (ClarisWorks and HyperCard) and that would be of practical relevance to teachers. He invited the participation of a public high school computer specialist with whom he had worked previously and of a district coordinator of computer services. Both were teachers with over twenty years of experience who had taught workshops and courses for other teachers and were enthusiastic about attempting a writing project. The final member of the team was an instructor of computer education in a department of Curriculum and Instruction, who had previously been a teacher and a computer programmer/analyst and had published previously in the computer education field. Each of the collaborators provided different strengths that contributed to the quality of the final product.

The Publishing Process

Currently, some publishers use newer technologies in the publishing process. Authors are now sometimes able to provide finished copy on disk or to communicate via e-mail with publishers, but many publishers are still using a very traditional publishing process. In this paper we will describe the traditional publishing process that the publisher involved still maintains, as background to how we divided up the responsibilities for the project. In the description our references to author, in the singular, can be applied equally to multiple authors.

Proposal

The process begins with a proposal letter to the publisher, describing the project, the expected market for the book, and current publications that would be in competition with the proposed text. At this point an acquisitions editor may ask for a sample. If all goes well a managing editor is assigned to the project and has primary responsibility for the text for the duration of the project. Upon acceptance of the proposal, and after any negotiations regarding royalties, a contract is signed. The managing editor assigns a production editor (sometimes called a developmental editor) who is responsible for the details of taking the book through a series of editing steps to create a final typeset product that is ready to be printed.

First Draft

A first draft of the book is written, and the author sends a hard copy print to the managing editor. The managing editor sends copies of the draft to reviewers. The reviewers are people outside the publishing company who are experts in the content area. They read the first draft and provide their opinions on the quality and marketability of the book, including annotated comments on the manuscript. The author then edits the draft, giving consideration to changes suggested by the reviewers and the managing editor.

Final Draft and Copy Editing

When all corrections have been made to the first draft, the production portion of the publishing process begins. The author prints a final draft and sends it to the production editor. Usually chapters are sent to the production editor as they are completed, either individually or several at a time, rather than all at once. The production editor sends the final drafts of the chapters to a copy editor who edits spelling and grammar errors. The final draft, with copy-edited markings, is returned to the author who approves or disapproves copy edits, marks any other necessary corrections, and returns chapters to the production editor as they are completed.

Concurrent with the writing and editing of the final draft, the production editor selects an artist to design a layout of the book. The layout includes all aspects of the interior of the book, such as: page size; format of the title page, text pages, and appendices; selection of fonts and type styles for text, headings, and captions; and arrangement of figures and graphics. The layout created by the artist is subject to the approval of the author (Editors note: that is not the case with many publishers; authors do not always have approval rights over interior design or cover art).

Proofs and Galleys

Once the author has marked corrections on copy edited final drafts of chapters and returned them to the production editor, the production editor has the corrected final drafts typeset in the approved layout, including figures, tables, and text. Prints, called *proofs*, are made of each chapter. The author carefully edits the proofs, marks needed corrections, and returns them to the production editor. The production editor has the chapters printed again with all corrections. These prints, called *galleys*, are the last prints of each chapter that are subject to edit by the author. Except for being on oversized paper and having lower print quality, the appearance of the galleys are just like the book pages. The galleys are sent to the author who marks any final corrections. The production editor has any changes typeset and finally, the galleys, in a film format, go to a printer where the the book is printed and bound.

Several other tasks must be performed by the author concurrent with editing of proofs and galleys. The author must work with the marketing department, which designs a brochure for advertising and may engage in other activities such as placing advertisements in journals. The author must also work with the production editor on book cover decisions. The production editor provides the author with a choice of graphics either from commercially available graphic selections or from graphics designed by in-house or contracted artists. An artist designs the cover, usually with several variations for the author's choice and approval.

Variations in the Publishing Process

For this project, the authors were prepared to design the book layout and provide the publisher with formated, edited, desktop-published files that were ready to print. The authors anticipated that the publisher would need only to send the manuscript out to reviewers, copy edit the final draft, and approve the final, formated manuscript. The publisher initially agreed to this, but later chose to return to a more conservative approach. The final draft was submitted on disk (with accompanying hard copy), but proof and galley edits followed the traditional steps described above. Anyone with desktop publishing skills who wishes to write a book may want to find out exactly what the publisher is capable of, and willing to do, technologically in terms of e-mail, disk submissions, program compatibility, fax, and so on, prior to signing the contract. The traditional process is changing, but with some publishers it is changing very slowly.

Our Experience

In the different phases of the publishing process there are varying levels of work. We attempted to estimate what the levels would be, so that no author would have a disproportionate responsibility.

Initial communications with the publishing company were handled by the author who initiated the project, due to his prior experience with the company. This included negotiating the contract. Before beginning the writing several decisions were made, in an attempt to maintain consistency between chapters. The decisions included factors such as the general format of the tutorials, what basic features the book should have, what version of the operating system would be used within the tutorials, what basic terminology to use, and how figures would be created and used. Each author was assigned chapters based on content, expected time requirements, and each person's area of strength.

Each author wrote first drafts of the chapters and sent them all to the managing editor. After the chapters were sent to the outside reviewers and their comments were received, the team met to discuss the critiques and decide on changes related to the book as a whole. One decision made at this time was to create two versions of the book, due to the reviewers', and hence the publisher's, interest in a second program, Microsoft Works. Drafts for the ClarisWorks version would be completed first, followed by the five Microsoft Works chapters that would replace the ClarisWorks chapters for the second version. Other decisions made at that time were to rewrite the completed drafts of the ClarisWorks chapters to reflect the new version of ClarisWorks which had just been released and also to use a newly released version of system software throughout the text. These decisions greatly increased the writing task. Each author was responsible for making necessary changes to his or her own chapters and for producing a final draft that was ready for the copy editor. During this time some field-testing of drafts was done with in-service teachers who were learning similar material in graduate courses.

Before the final drafts were sent to the production editor to be copy edited, one author was assigned to carry the ClarisWorks version of the text from that point on through the production cycle. This person was also to handle all communications with the production editor. This decision was made for several reasons: four authors could have very different writing styles that needed to be blended; chapters written by different people needed to flow appropriately; misunderstanding of publisher information was less likely when one person had an overview of all communications; messages from the publisher were less likely to get lost; and the production editor's job was simplified, making it easier for the authors to maintain a good working relationship with the production editor throughout production. Before submission of final drafts to the production editor, the drafts were reviewed and edited by the author chosen to handle production. This person checked for consistency and for accuracy in terms of spelling and grammar and also tested each tutorial on the computer.

The responsibilities of the person assigned to take the project through this phase turned out to be far more extensive than was anticipated. Consistency related decisions, made prior in the writing process, proved to be inadequate. When editing on the final drafts began, numerous unanticipated variations were discovered. For example: one author would write "Drag the file menu to print" and another would write "Choose Print from the File Menu"; captions varied from none, to cryptic phrases, to expansive full sentences with titles; and insertion of figures was done differently by each author. Standardizing on aspects such as these and on use of capitals and quotation marks prior to creation of the final draft could have saved a considerable amount of editing time. Other unexpected editing problems arose from differences in each author's computer system. For instance, differences in screen sizes and display settings produced variations in screen prints used for figures. These variations were most efficiently corrected by redoing the screen prints on a single computer.

Two other factors also impacted the editing time. One factor was due to the problems inherent in having a copy editor who appeared to be a novice and was not familiar with the content. (This can particularly be a problem when programming and computer terminology are involved. For instance, in our experience copy editors have been known to edit BASIC and Logo programming code into English, and to edit screen prints.) In this project a lot of time was spent correcting the copy editor's "corrections." The assignment of a copy editor may be something best negotiated into the contract, if possible, so that someone with an acceptable background is assigned, perhaps subject to author approval. Another time-increasing factor, was the publisher's decision to change from a desktop publishing process to a traditional process. Because the publisher had never used anything but a traditional process, they were reluctant to release control of a major phase of the production cycle. One concession they did make was to accept the copy-edited and corrected final drafts on disk rather than on paper and to format the book themselves, using Quark, a desktop publishing program for the Macintosh, rather than sending it out. This allowed the authors to have slightly more direct and immediate control over changes than would have been possible in a purely traditional process.

The editing cycle was anticipated to require a large amount of time, but this portion of the project was even more extensive with four authors involved. For the ClarisWorks version of the text, however, one author had responsibilities of the production cycle. The multitude of details known and understood by that person could not be efficiently relayed to the others, particularly since all the authors had responsibilities for first and final drafts of the Microsoft Works chapters while the first text (the ClarisWorks text) was still going through the production cycle. For the Microsoft Works version of the text, communications with the production editor remained with one author, but the editing was distributed a little more evenly. This was possible for several reasons. Only five new chapters were written (the Microsoft Works chapters), while the other chapters had relatively minor changes. Consistency decisions were made prior to writing the new chapters and the copy editor was more familiar with expectations. Thus, each author was able to do more editing of copy edited final drafts and of proofs for his or her own chapters, with the assigned editing author doing primarily a quick final review at each editing step.

Two 350-page books with tutorials and exercises, and a data disk accompanying each text, containing data files for exercises, were the final result of this project. It took slightly over two years from start to finish for four authors holding full-time jobs to complete the project. Although it required a great deal of time and effort from each author, all were happy with the results of the project and would engage in such a collaboration again.

Suggested Do's and Don'ts

The authors found several do's and don'ts to pass on to others who are beginning collaborative projects such as the one described.

1. Do collaborate. In the university/school partnership each person has things to contribute and to learn. Everybody benefits.
2. Do make consistency decisions early in the process. Consider known factors before you even start. Review each other's first draft of early chapters for possible inconsistency problems.

3. Do listen to reviewers, but don't assume reviewers are right. You do not have to make changes recommended by reviewers. Respect their views and the great value they bring to the process, but weigh the recommendations of everyone involved (authors, editors, marketing staff, etc.) against your own knowledge and experience.
4. Do field test materials.
5. Do keep communications channels open. Because two authors were a thirty minute drive from the other two, special arrangements had to be made for hard copy to be passed quickly between authors. (Some copy, such as manuscript pages with reviewer comments, could not be transmitted electronically with the equipment we had available.) This sometimes slowed the process. Early in the project develop efficient plans for sharing drafts, sending copy-edited manuscripts, making copies of prints when necessary, and maintaining general contact (both among authors and between the authors and the publisher).
6. Don't let ego hamper the process. In our attempts to meet deadlines, many editing changes made by the author assigned to the production cycle were passed on to the publisher before the author who had written the material had a chance to review them. At one point, one of the authors was disturbed by some extensive changes; she felt that she had lost ownership of the writing. Fortunately, she was able to express her concern, but didn't let it affect the collaboration, and attempts were made to avoid similar further problems. However, events like this cannot be entirely avoided. This example emphasizes the importance of working hard to keep the lines of communication open.
7. Do always work to try to meet deadlines, but also do be aware that deadlines cannot always be met. Family and personal commitments can cut into an author's ability to complete work, no matter what the intentions are. In a collaboration the inability of one person to complete or not complete a task on time can greatly impact the work of another. Be prepared to reassess and readjust schedules repeatedly, as necessary.
8. Do be aware that the division of work will not always be equal. No matter how hard you try, there will always be times when one person's responsibility will be greater or lesser than others. Trust everyone to contribute to the best of his or her ability over the long run.

Conclusion

This collaborative writing experience was so positive overall that the four authors are considering a second edition and the possibilities of developing another project together and would strongly encourage others to participate in similar collaborations. The combination of university and school experiences of the authors contributed significantly to the success of the project

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Selected Case Studies in Internet Based Post-Secondary Distance Education

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The Globewide Network Academy (GNA) is attempting to bring about a revolution in the realm of post-secondary distance education. GNA's primary long term goal is the formation of a fully accredited university based wholly on the Internet. To bring this about, the world's first virtual corporation, Globewide Network Academy Inc., was formed. GNA grew out of the Usenet University, a non-accredited on-line education initiative started in 1992. There is also a great deal of cooperation between GNA and Diversity University in building a workable virtual campus, complete with special tools and resources to facilitate both learning and teaching in cyberspace. This paper will briefly discuss terms used on the Internet, then examine the efforts of Usenet University, Globewide Network Academy, and Diversity University; three organizations attempting to shape the future of post-secondary distance education on the Internet.

The Internet

The Internet is the common name for a collection of many different networks that all share a few common information transfer protocols. This "network of networks" (Kehoe, 1992) contains several major subdivisions, including the Usenet, a collection of special interest newsgroups and the World Wide Web, a networked system of hypertext, multimedia documents. A person can access the Usenet through a server that subscribes to some or all of the more than 2000 newsgroups. Usenet users can read other people's posted messages or post their own. On the Web, a user accesses a Home Page, a specific hypertext document with links to many other documents, through any server connected to the Internet. The use of both Usenet and the World Wide Web requires special client software to help decode the information from the server. Other programs available on the Internet are: FTP, or File Transfer Protocol, which allows users to transfer files from one computer to another; Gopher, a simple Internet navigation tool; e-mail, which allows a person to send messages and files to other people; and MOOs, which are text based virtual realities created to be accessed through the Internet.

Usenet University

Usenet University was founded to be "a society of people interested in learning, teaching or tutoring" (Usenet University FAQ, 1993) rather than a formal institute of higher learning. [Editor's note: FAQ is short for Frequently Asked Questions and is the shorthand used to indicate a document on a particular topic] The goal was "to use Usenet communications to offer participants possibilities to learn things, to educate themselves, to teach others, to exchange information on learning materials, tools and techniques, as well as publish learning material itself" (Usenet University FAQ, 1993). Usenet University was to be a place to learn, open to anyone, a community.

Usenet University courses were offered over the Usenet, an Internet based network of special interest discussion groups. On June 12, 1992, the original Usenet University newsgroup, *alt.uu.futures,* was formed. Designed to be a place for the discussion of the future of the project, the newsgroup developed into the center for most of the administrative and design discussions as well. On July 22, 1992, ten other newsgroups were formed. Each was to be the discussion area for a particular educational topic. The newsgroup *alt.uu.math.misc,* for example, was designated the Math Department of the Usenet University; and *alt.uu.lang.esperanto.misc,* the Esperanto Department. Other areas of study included computers, Russian, and virtual worlds. None of the departments of the Usenet University had actual faculty, instead all information was provided by the participants themselves. Those participants who knew more about a subject were expected to share with those who wished to learn. There were also areas for the discussion of special educational tools and Usenet University courseware. The project charged no tuition or fees to take part in any of the discussions.

The administration of Usenet University was set up more to moderate the newsgroups than to dictate the contents and curriculum of the "courses" offered. The organizers believed strongly in learning by "tossing ideas around and discussing them, asking each other and helping each other out," (Usenet University FAQ, 1993). All decisions regarding the University were discussed thoroughly on alt.uu.futures before being enacted. The organizers of the University had no desire to build an accredited institution, although they thought that some recognition of the learning that took place in the University might be forthcoming, as more traditional institutions became aware of the value of their courses.

In 1993 Joseph Wang, one of the Usenet University contributors, came up with the idea of creating the Globewide Network Academy after he decided that "the Usenet University, solely based on newsgroups, had turned out to be ... not really suited for the organizational and educational tasks" which he wanted to target (Speh, 1994). After the development of the GNA, the Usenet University began to decline as an educational organization. Alt.uu.futures has become the main discussion area for GNA development and it mirrors the GNA-Talk listserv. While the other newsgroups still see some occasional activity, they are, for the most part, defunct.

Globewide Network Academy

> GNA is a non-profit corporation incorporated in the state of Texas since November 1993, affiliated with the Usenet University project. Its long-term goal is to create a fully accredited on-line university. To reach this goal it has short term plans for 1993-94: the fall '93 semester was devoted to establishing the basic educational, technical and administrative infrastructure. By summer 1994, GNA shall have released a press release, a newsletter, and a catalog of classes . . . GNA is also the world's first virtual corporation, and therefore serves as a testbed for running organizations in the 21st century. It shall also be an 'umbrella' bundling educational Internet initiatives and easing the interaction between professionals worldwide. (GNA FAQ, 1994)

The Globewide Network Academy exists only on the Internet. Physically it consists only of data stored on computers around the world and an article of incorporation in a Travis County, Texas court record. All official meetings and instruction occur over the cables and carriers of the world's computer systems. As a corporation, GNA has a legal existence, but no offices or holdings, only officers and information. The Academy also has a goal, to build and deliver a curriculum of instruction that will be formally acknowledged by the accrediting agencies of the world to be the equivalent of that offered by any traditional institution of higher learning.

Unlike Usenet University which based its instruction on informal discussions on the Usenet, GNA offers formal, organized courses that take advantage of all avenues of the Internet. The majority of GNA documents and texts are based on the hypermedia of the World Wide Web. Classes and administrative meetings often take place in one of the virtual campuses at MOOs around the Net. Participation is not restricted to learners who can access these programs. GNA is devoted to making its classes accessible to as many people as possible, so all documents can be obtained through simple e-mail, the most basic of Internet programs.

The GNA curriculum is still mostly theoretical. The Academy is currently offering two experimental courses; one called "Introduction to the Internet" and the second "Introduction to Object-Oriented Programming Using C++" (GNA Course Catalog, 1994). Registered to start soon are five other courses on topics ranging from environmental microbiology to renaissance culture. Several classes are planned for the future, including two creative writing courses and a math course. The experimental nature of GNA's courses prohibits their being accredited at this time. As more courses are offered and more information gathered on what does and doesn't work, the GNA faculty will be able to discover more effective instructional strategies for Internet based courseware. As more quality courses are added to the GNA curriculum, the Academy learns more about how to teach over the Internet and they come closer to their goal of full accreditation.

As GNA is a legally incorporated non-profit organization, it is required to have a certain organizational structure. There is a Board of Directors, with five elected members; a Chairman of the Board, who oversees the Board of Directors; and a President, who is the Chief Executive Officer for the corporation. The Chairman and the President are elected by the Board of Directors. The officers and the Board have the final decision making power, and accountability, for the Academy, but the majority of the decision making process takes place in public meetings and discussions which usually take place in one of the virtual meeting rooms in M.I.T's MediaMOO. These meetings are mirrored to several other MOOs around the Net. The rest of the discussion takes place on the alt.uu.futures news group and the GNA listservs.

Some of the other initiative that fall under the GNA organizational umbrella are the GNA Meta-Library, a searchable database of information resources across the

Internet; the Consultants Network, people who can answer GNA or Internet related questions by e-mail; the Collaborative Textbook Project, which creates free text books for use in on-line classes; and the Virtual Campus, a collection of electronic classrooms, laboratories, and meeting places. Each project is overseen by an independent committee which reports to the President and the Board, but receives little actual supervision.

All software and materials created by the Academy are copyrighted by GNA and are subject to the open distribution clause laid out in the GNA policy manual. "GNA shall encourage the open distribution and use of software and textbooks developed by it and their use in organizations (including competing universities), provided that proper credit and acknowledgment is given to the university and to the individual developers ... GNA shall retain the copyrights to materials developed by it for the sole purpose of seeking to maintain open distribution of works published by it." (GNA Policy Manual, 1994). All software is distributed with all of its programming code accessible to the end user.

As a non-profit corporation, GNA's primary goal is not to make money. But every organization requires resources to operate. Currently, GNA gets those resources from volunteers. None of the officers are paid. All of the work done on GNA projects and classes is done by people willing to invest time and effort in a new, and somewhat risky, endeavor. To help meet the ever increasing need for resources, GNA has instituted a policy that tuition for classes can be paid in service, facilities, or other non-monetary resources. For instance, students attending a class on Internet basics might be required to give time answering questions on the Consultants Network after the class ends. Or a class final project might be the collaborative production of a textbook that can then be use to teach later classes. As the Academy grows, and the classes become less experimental, instructors will be able to decide whether to charge a monetary tuition for their instruction, or to continue to use the current system. "The GNA will have, ultimately, a mixture of free and tuition based offerings. As a non-profit corporation, the GNA is not out to make money; at the same time, revenues are needed to support the staff and machines that make the GNA happen. For this reason, it is likely that some of the GNA's programs will ultimately require tuition. This will vary on a course or program basis, and information concerning the status of any particular course or program will be contained within its documentation," (GNA FAQ, 1994).

Over the next few years GNA will be working to build the administrative and academic infrastructure necessary to fulfill its goal of becoming a fully accredited, degree granting university based wholly on the Internet. The current almost anarchic nature of the Academy; with the Board of Directors and the Officers being the only formalized authority presently in place, and the rest of the discussion and decision making process taking place in open meetings and debates over the listserv; makes it difficult to create a structure that a majority can agree on, yet will still meet the traditional qualifications for an accredited institute of higher learning. In order to avoid the near impossible task of getting a diverse group of individuals, such as that which makes up the voting body of the Academy, to agree on a single way of building a structure and curriculum which will meet the Academy's goal; the Board has agreed to grant charters to any group that wants to try to build a curriculum. The plethora of curricula that may grow out of this decision should form a aggregation of experimental data on what is and is not effective; knowledge which is useful regardless of the success of the individual programs. The GNA development plan calls for the final steps of full accreditation and the first degree granted by Fall of 2005.

Diversity University

Diversity University is an educational project that works closely with the Globewide Network Academy in trying to build a virtual campus and tools and resources to help both learners and teachers in the virtual classroom. Founded by Jeanne McWhorter, a graduate student at the University of Houston and current GNA Board member, DU has concentrated most of its efforts on building its MOO based campus. McWhorter decided that limiting the pseudo-geographical area of the campus would make it easier on the people who visit it. She set the physical boundaries to a five by five square block area. McWhorter also realized that the University needed the potential for growth, so she designed the space so that the campus could support an infinite number of building with an infinite number of rooms. Each room can be designed to meet the needs of the people using it.

DU offers three important resources to its patrons; real time interactivity, preprogrammed presentation capability, and easy access to the information cataloged on the Internet. Each room or space in DU can hold numerous users who can interact with each other in real time. The GNA Board, for example, meets in the GNA Cafe, a permanent location in the MOO. There the Board can discuss matters with each other without the lag of a newsgroup or an e-mail list. Also, the entire meeting can be saved to a text file so there can be a permanent record of what was said and done. Lecture rooms are specially designed rooms in DU where classes can meet. In the lecture rooms the teacher can speak without interruption, unless one of the students raises his hand, signaling that he wishes to speak. Unless the teacher relinquishes the floor, no other speaker's text can be seen. Another tool available to the instructor is MOO TV; which has little to do with actual television, save that both are prerecorded presentation media. MOO TV can be used to build a text based simulation of an historic event or a scientific phenomenon; or it can be used to pre-record a lecture so that the teacher doesnÕt have to type it in real time. Interactivity can be programmed into MOO TV by more experienced users, allowing for interactive instruction and testing without requiring the teacher's presence. In the University's library is the InfoCenter, providing easy access to various gopher locations;and other subject databases. DU also has its own FTP site, where class materials and meeting archives can be stored and accessed by students and teachers.

DU offers no classes and is not seeking any sort of accreditation. Instead DU provides a place for GNA and other groups to meet and for instructors to hold class. There is no charge to use DU services, and like GNA, DU operates solely through the efforts of volunteers. What little administration there is, mostly offers technical support for the University and its patrons. Any interested user is encouraged to build a room, teach a class, or design his own program. In the future, DU hopes to improve its environment, its tools, and its presentation capabilities in order to meet its goal of creating a place to "teach as much as possible in as creative and unique a way as possible." (What is DU, 1994)

Conclusion

The idea of an accredited on-line university seems to be rapidly gaining popularity. UU, GNA, and DU are just three of the Internet based educational initiatives currently emerging. The Electronic Multimedia University, in Europe, and the Global Telecommunication University, proposed by the International Telecommunications Union, a branch of the United Nations, have the establishment of an accredited electronic university as a goal. Several traditional universities are offering single courses on-line. The future of long distance education may be shaped by what GNA and others accomplish. The whole paradigm of traditional face to face education may be shattered. The traditional requirements for accreditation may have to change to fit universities without concrete artifacts or boundaries. Or GNA's efforts may give rise to the accreditation of individual courses and programs rather than of whole institutions. Regardless of their eventual success, Usenet University, Diversity University, and the Globewide Network Academy are the start of a new trend in post-secondary distance education.

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HYPERMEDIA/MULTIMEDIA

Section Editors:

Ray Braswell
Jerry Price
Michael Connell

A student was having trouble deciding on a research project to do for his end of the year assignment. The teacher, knowing that the student could come up with a project if he 'applied himself', told him, "Well, I guess you're between a rock and a hard place, aren't you?" A glimmer of inspiration flashed across the student's brow and he immediately raced to the classroom media station and put a CD-ROM into the drive. After several furtive moments, the teacher walked back to the student. In frustration, the student turned to the teacher and proclaimed, "Well, I can find Iraq, but I sure can't find this Hardplace you told me about!"

Much like this student, are we as educators simply accepting the incorporation of these technologies into our classrooms and our lives? Do we too quickly embrace the latest innovation as a panacea to our problems? Or are these technologies merely the latest request to our local PTA organizations for next year's funding? *Why* should our students be utilizing QuickTime in the classroom? *Why* do we want to develop hyper/multimedia presentations for use in our work and classroom? Is the old adage that we are adapting the teaching to address the differing learning styles of our students applicable to the capabilities we have today? If we can not answer these questions, and the many others like them, then *Why* are we using these technologies in our classrooms?

As I read through the papers in this section of the Annual, I am pleased that the authors are not merely reporting on what they have done and saying "Look at me!". Each of the authors provides insights for all of us as to both the how *and* why we should be teaching, developing and creating using hyper/multimedia. Particularly notice that not only are the teachers utilizing hyper/multimedia, but they are allowing their students to become not only users, but creators as well. I am always pleased to see that the articles for this section cover such a wide spectrum of ideas and intended audience. Notice the range of experiences that each of the authors brings to this area. Notice the innovative concepts that are presented. Use these ideas to bring new methods into your own teaching! We must remember, that as educators, our product - our students - reflect our quality control. The authors in this section have indeed chosen to follow this path.

As you look at these papers, I would like for you to examine them in four areas. (This, by the way, is where I got the idea for the opening story!)

R - Research. Do each of the authors provide a substantial basis for their work? Do they explain why they attempted to do what they did? Did the hyper/multimedia aspect of the work provide an additional benefit, or was it part of the just because we can school? As I examined the papers, I found many excellent examples of good research being practiced in this area.

O - Originality. Do the authors bring new and innovative work into the classroom? Do they tell you WHY they are doing *what* they are doing? Do they provide examples of how things did and did not work in their classroom? Each year, as I read through the articles for the hyper/

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multimedia section, I never fail to find original ideas that make me want to incorporate them into my teaching. The articles which follow are no exception; many excellent ideas are to be found in each.

C - Creativity. Wow! I can only say that I would love to see some of these authors at work in a classroom. I can only imagine the joy and fun in learning which takes place. I would love to talk to some of the students as they demonstrate the things they have learned and are now able to carry over into other subjects and their lives. I would like to see the pride with which these students show others what they have done.

K - Knowledge. Do these articles bring knowledge to others who wish to incorporate hyper/multimedia into their classroom? Do they show an understanding as to how our students learn? Do they provide information so that others, like myself, can use these projects in our classrooms? Do they provide guidelines so that we can help our students learn? To these questions, I issue a resounding "Yes".

Read these articles. Use the information. Create and share and enjoy. This is the stuff that makes us grow. And it won't do you any good trying to find Hardplace!

Software Development for a Microteaching Laboratory

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Cleveland State University

This article presents an overview of the ongoing development of software for a microteaching laboratory in the Cleveland State University College of Education. To assist with the teach-feedback-reteach microteaching cycle, the laboratory uses video recording and playback equipment. In addition to the traditional equipment of microteaching, the laboratory instructors use portable computers, printers and custom software for recording and providing feedback to students.

The first section of this paper provides a brief rationale for incorporating microteaching in a pre-service teacher education program. The subsequent sections discuss the prototyping model used in the development of feedback software for microteaching. Finally, the lessons learned from the initial development effort are described, and future directions for software development are presented.

Microteaching

A primary goal of teacher education is to prepare pre-service teachers to implement a variety of instructional strategies. To be successful, a pre-service teacher must first learn how to implement a strategy and second they must know what strategy is appropriate for a particular classroom situation. Acquiring these skills requires practice at teaching and teacher education programs provide numerous opportunities for pre-service teachers to teach, from one on one tutoring in clinical settings to student teaching in classrooms.

The instructional demands present in a tutorial setting are different from teaching an entire class. The goals of tutoring are specific and the instructional setting is relatively straightforward. Classroom teaching, however, presents a complex environment where learning variables and student behaviors interact continuously. How these classroom variables are manipulated influence what type of instruction occurs. Whereas experienced teachers monitor classroom variables and use this information to guide their instruction, pre-service teachers are less likely to distinguish between important and inconsequential classroom variables and thus apply instructional strategies less effectively.

How does one encourage preservice teachers to be more reflective and flexible in their teaching while providing opportunities for practice? One approach, microteaching, provides opportunities to practice different courses of action under circumstances where the number of learning variables and student behaviors are controlled. Microteaching was originally developed at Stanford University in the 1960's (Allen & Ryan, 1969) The basic format of microteaching includes teaching, feedback on teaching, and restructuring of the lesson for re-teaching(Flowers 1988). Microteaching is a scaled down teaching encounter. The number of students taught is less than a typical classroom and the time of the microteaching is limited to reduce the complexity.

Concurrent with the introduction of microteaching in the 1960's was the introduction of lower cost video technology. During the past thirty years video technology has assumed a greater role in teacher education and considerable research has reported on the efficacy of this technology in teacher education (Frager, 1985) Although, the originators of microteaching (Allen & Ryan, 1969) did not consider videotaping as an essential component of microteaching, current implementations normally include the use of video recording equipment. Empirical research studies (Frager, 1985) suggest that under controlled conditions the use of videotaping can improve the quality of teacher training. In particular, studies of the use of video technology for feedback in microteaching suggest that benefits accrued from the interaction among pre-service teacher, supervisor and the video record of the teaching act are considerable.

Software Development

Experiences with other software development projects (Abate & Benghiat,1992, Abate & Hannah, 1993) suggest that faculty are more likely to adopt and use custom software if they are directly involved in the design and development process and if they are aware in advance that revision is a major aspect of the software development effort. A software development plan based on the b-model (Birrell & Ould,1985). was selected by the Center for Applied Educational Technology (CAET) at Cleveland State to encourage collaboration and revision input from faculty. The b-model separates software development into a development path and a maintenance cycle. The development path consists of five steps;

Inception- decide what to do for some reason,
Definition - agree on what is to be done,
Design- work out how to do it,
Production - do it, and
Acceptance - have it accepted by the clients.

Although the steps appear as a linear progression there is considerable movement across and among the steps. The microteaching (MT) software reported herein is currently between the definition and design phases.

To address the goals of encouraging collaboration and revision, the development path used for the MT software was augmented with a prototyping cycle that runs concurrently with the definition and design steps. The prototyping cycle employed for MT software development was adapted from Birrell and Ould(1985). (See Figure 1.)

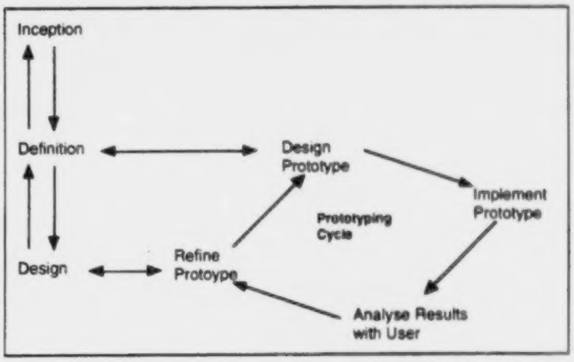


Figure 1. The b-model Prototyping Cycle

Software prototypes are developed to demonstrate in a short period of time the utility and viability of a design before it is cast into a final form. They allow for experimentation with new ideas which may not have been apparent in either the inception or original definition steps of development. The ever increasing number of very high level languages, such as HyperCard, SuperCard, Authorware, and Director allow for the rapid production of and support for prototype development. Prototyping of teacher education software has been a consistent feature of the CAET software development efforts (Abate, 1990; Abate & Benghiat,1992).

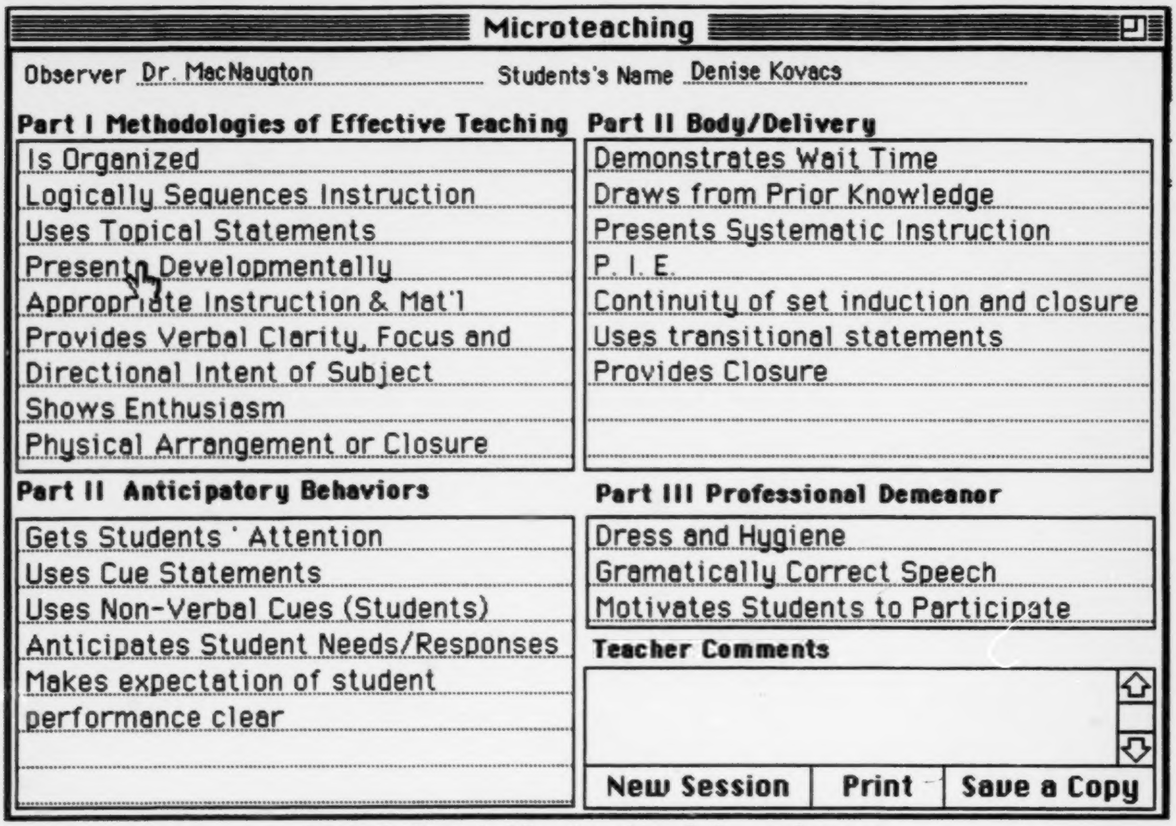
Project Inception

The undergraduate curriculum for elementary education at Cleveland State University was revised in 1994. Part of the curriculum revision involved formalizing microteaching as a integral component of the general methods course. Prior to the revision, individual instructors decided if microteaching would be included in their section of a general methods class. The decision to include or exclude microteaching from the methods course was more a function of available teaching space and equipment than a pedagogical decision. As such, the first step in providing long term support for microteaching was the administrative decision to purchase mobile video equipment. Four camcorders, monitors, carts and video playback machines were purchased. In addition, four classrooms were scheduled to support student microteaching sessions.

Aware that other faculty members had incorporated technology into their courses, the methods faculty inquired about the potential of utilizing computers in microteaching. Initial meetings between the design team and faculty consisted of presentations of previous software development efforts followed by an informal needs assessment of the microteaching activity.

Three key issues were isolated during the needs assessment. Two issues revolved around providing student feedback. First, the original methods employed by the faculty included a "checklist" to indicate whether particular teaching behaviors occurred during microteaching. Unfortunately, not all students recognized that they executed a particular teaching behavior even if it was indicated on their copy of the checklist. The "checklist" system failed to point out when a teaching behavior occurred during a teaching sequence. Thus, it was difficult for students to analyze the videotape of their teaching sequence with the checklist. A second very practical problem existed when it came to providing feedback. Faculty needed to record the results of each session yet only one copy of the checklist was created per student during microteaching. As such, students frequently had to wait until the following class meeting to receive a copy of their checklist before they could compare the checklist with the videotape of their teaching.

A third issue revolved around competency with technology. The methods team felt relatively comfortable using the video technology but had reservations about adding computers to the task. It was stressed that if computers were to be integrated into microteaching it was essential that they be simple to use.



Microteaching

Observer Dr. MacNaugton
Students's Name Denise Kovacs

Part I Methodologies of Effective Teaching

Is Organized
Logically Sequences Instruction
Uses Topical Statements
Presents Developmentally
Appropriate Instruction & Mat'l
Provides Verbal Clarity, Focus and
Directional Intent of Subject
Shows Enthusiasm
Physical Arrangement or Closure

Part II Body/Delivery

Demonstrates Wait Time
Draws from Prior Knowledge
Presents Systematic Instruction
P. I. E.
Continuity of set induction and closure
Uses transitional statements
Provides Closure

Part II Anticipatory Behaviors

Gets Students ' Attention
Uses Cue Statements
Uses Non-Verbal Cues (Students)
Anticipates Student Needs/Responses
Makes expectation of student
performance clear

Part III Professional Demeanor

Dress and Hygiene
Grematically Correct Speech
Motivates Students to Participate

Teacher Comments

Figure 2. Sample Microteaching Software Screen

The project inception phase led to the following conclusions; 1. that the faculty were motivated to alter their methods of recording and providing feedback to microteaching students, 2. that any software created for the microteaching would have to be simple to use, and 3. that there was sufficient potential to consider the addition of computer technology to the course.

Definition and Design Phases.

The primary purpose of the definition phase was to decide what was to be produced. From the outset considerable effort was invested in establishing and maintaining communication channels between the CAET design team and the methods faculty. It was mutually agreed upon that the initial software developed for the microteaching laboratories should reflect current practice as closely as possible thus reducing the potential for confusion and providing a means to transition from the familiar world of a paper and pencil implementation to less familiar world of computer implementation. The faculty were informed that this software development effort would require the production of prototypes and that they were encouraged to suggest revisions at any time.

The original software specifications proposed by the faculty mirrored the original paper pencil version. Categories of behaviors that could be check off and areas for providing open ended comments were included. A prototype was quickly developed for the faculty to test. The prototype received mixed reviews. Faculty who were familiar with the Macintosh computer found the prototype easy to use, those who were not failed to see any benefit in this approach over paper and pencil version. The design team agreed that the first prototype offered few advantages over the original other than the ability to print out the students results.

A review of the original needs assessment with the faculty led to the inclusion of a timing routine on the second prototype. This routine recorded the behavior and current time of the videotape each time a behavior was selected by an observer. For example, when an instructor recorded that a student engaged in a set induction behavior such as "relating to past and future learning" the computer marked the selection, recorded the behavior, and recorded the number of minutes and seconds into the microteaching lesson. Thus the student or observer could refer to the time listed on the form to find the exact sequence on the videotape. Each faculty member was given training on this version of the prototype and was asked to test it to determine if the new version met their needs. Response to the overall form of the prototype was positive but individual faculty members felt constrained by the behavior choices listed on the form. In other words, not all faculty members agreed on the categories of behaviors listed and requested the creation of a flexible software form that would allow for the creation of different types of microteaching forms.

A third prototype was developed that allowed for the alteration of category headings and microteaching behaviors. This version was tested with students during classroom microteaching exercises. Each faculty member was provided with a Macintosh PowerBook computer with the prototype software installed. A printer was added to the equipment cart to allow for printing of feedback following a microteaching session. Recording of input occurred on a single screen. (See figure 2) Specific behaviors were recorded by clicking the mouse on a chosen behavior listed on the screen. Open ended responses were typed into a "Comments" text field.

The third version was tested for one quarter with students during two different microteaching sessions. Faculty comments on the prototype were favorable. They were generally pleased with the utility and functionality of the prototype. What made the comments interesting was the faculty impression that this prototype was the finished product.

Lessons Learned

The goals identified during needs assessment were addressed in the definition and design phases. The prototyping cycle encouraged the faculty to take a more active role in the design and refinement of their software. It also led to the addition of features such as a time record and flexible behavior labeling form. Neither option was identified during the project inception step. Both options surfaced as a result of maintaining open communication channels between the CAET design team and the eventual faculty users. Communication and revision were essential to the development process. This proved to be the most important lesson learned.

Given the technology experience of the faculty, the design team was pleased that the faculty were willing to take the risk of using unproven software in a classroom setting. In addition, students enrolled in the microteaching sections viewed the combined technology set up of video camera, computer, printer and cart as standard equipment for the course. The faculty view of all this equipment was not as positive. Although the equipment performed as desired, both the faculty and the CAET were not satisfied with the equipment set up. The cart and associated equipment were heavy, cumbersome and there were simply too many wires, cables and connections to consider the set up as user friendly. It was not clear what could be done to alleviate the hardware problems although future digital video technologies may eliminate many of the constraints.

Future Directions

As a first step toward addressing the lessons learned, the faculty and CAET will continue to refine the MT software. Major changes are not anticipated at this time. However, additional refinements may lead to substantive changes in the product design prior to final acceptance of the MT software. Unlike traditional software development, the CAET places greater emphasis on developing software that will be used and less emphasis on the timely delivery of a finished end product.

One anticipated change in approach considered is to provide faculty developers with the b-model during project inception. Access to the model will outline for faculty the different phases of their software development efforts and help to clarify the responsibilities of both the CAET and the faculty.

The b-model augmented by a prototype cycle proved to be an effective method for maintaining communication and facilitating collaboration with the faculty end users. The phases of the prototyping cycle supported an environment that encouraged constant revision. This type of environment also helped to personalize the development process. Before entering into the MT software development effort, the CAET considered several alternative models for guiding the development process. In review, the prototype augmented b-model encouraged the active participation of the faculty users. The b- model is consistent with the philosophy of the CAET to let the users establish the direction of software development. It is anticipated that the prototype augmented b-model approach will be utilized in future software development efforts.

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The Process of Developing Interactive Multimedia Materials for Preservice Education: Negotiation, Collaboration, Presentation

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> Any program that seeks to enhance the quality of teaching and learning in mathematics must allow teachers to develop, in practical terms, a clear vision of what these changes mean for their own personal professional behavior. It implies that teachers actively reflect on their current practice and make a professional commitment to work toward an improved and expanded repertoire of teaching skills (Lovitt et al., 1990, p. 230)

Negotiation, Collaboration, Presentation: A Model for Mathematical Problem Solving is an interactive, multimedia program designed to provide preservice and inservice teachers with a vision of a mathematical classroom environment perhaps different from what they experienced in school. The program was designed with the following principles in mind:

1. Mathematical learning involves the construction of patterns and relationships (National Research Council, 1989; Steen, 1990).
2. Problem solving and communication (written and oral) are vital to constructing mathematical relationships (Cobb et al., 1991; NCTM, 1989).
3. Unless individuals can be provided an opportunity to construct viable alternative models of instruction, they are likely to teach the ways in which they were taught (Atkins, 1993; Barron & Goldman, 1992; Simon, 1994).
4. Curriculum, instruction, and assessment are tightly woven facets of teaching. These aspects cannot be adequately examined as isolated parts but must be explored in concert with one another.

The title *Negotiation, Collaboration, Presentation* describes the three phases of the problem solving lesson captured on video. The lesson begins with the negotiation of the task. The students are given five mathematical problems which they read aloud and then negotiate what they are being asked to find. At no time during this phase do they discuss how to solve the problem. Phase two is collaborative problem solving. The term collaborative rather than cooperative was chosen since the students are not placed in specific small groups. They are free to work alone or with others, moving from group to group as they choose. The only constraint is that they must remain focused on the task. The final phase is the presentation of solutions. Students who signed up to present problems during phase two present their solutions. This presentation phase includes a discussion of the solution given, offering of alternative solutions, and acceptance of the solution as being **one** viable solution.

Although negotiation, collaboration, and presentation was originally conceptualized as a three phase process, each separate from the other, upon further reflection I began to see these three components as tightly interwoven threads of problem solving. Just as I began this process with the belief that curriculum, instruction, and assessment could not be dissected into separate entities but must be examined in concert with each of the other components, I now believe that the same is true with negotiation, collaboration, and presentation. In addition, I realize that the interwoven threads of negotiation, collaboration, and presentation not only describe mathematical problem solving but also describe the transformation of the conceptualization of a multimedia idea into a teacher education product.

The creation of *Negotiation, Collaboration, Presentation: A Model for Mathematical Problem Solving*, teacher education multimedia materials, involved the ongoing negotiation of the task among the four key players: classroom teacher, mathematics educator, Instructional Media Services (IMS—in charge of filming the lesson), and the Center for Applied Educational Technology (CAET—administers the videodisc project at Cleveland State University). This process included the negotiation of:

1. project support from CAET (CAET, mathematics educator);
2. the problem solving mathematics lesson which would be filmed (classroom teacher, mathematics educator);
3. the filming of the lesson including camera angles, microphones to be used, room arrangement, lighting (CAET, IMS, mathematics educator);
4. the video edits to be used for the final product (CAET, mathematics educator);
5. the narration for the final product (mathematics educator, classroom teacher, CAET, IMS)
6. the "look" of the final videodisc product (CAET, mathematics educator, IMS)
7. the interactive lessons using the videodisc including the authoring system to be used (CAET, mathematics educator)

As you can see, I cannot discuss the negotiation process without alluding to the collaborative structure of the project. This project could not have succeeded without the cooperation of each of the key players.

Project Support

The Center for Applied Educational Technology has been committed to providing the faculty at Cleveland State University with opportunities to improve preservice teacher education by integrating technology into the college classroom (Abate & Benghiat, 1992; Abate & Hannah, 1993). Our collaborative effort emerged from my need to provide preservice and inservice teachers with a means to "shed previous conceptualizations of teaching and learning mathematics and to construct a new image in which their role and the students' role is redefined" (Atkins, 1993). The outcome is a series of multimedia lessons in which preservice and inservice teachers explore curricular, instructional, and assessment components in a problem solving mathematics lesson.

Problem Solving Mathematics Lesson

The lesson to be filmed was central to providing future users with a powerful image of a communicative, problem solving approach to mathematics teaching and learning. It was critical that the classroom teacher and students be experienced problem solvers. If not the video segments would appear artificial/staged. Luckily, I had worked on a project with a classroom teacher who regularly engaged his students in mathematical problem solving. The teacher had developed a problem solving format for lessons using Problems of the Day available through a Mathematics Problem Solving Bulletin Board sponsored by the Cleveland Collaborative for Mathematics Education. Each week the students collaboratively worked on these "bulletin board" problems. In viewing the students, I found that this teacher's approach to problem solving would provide us with a model for mathematical problem solving: Negotiation, Collaboration, Presentation. Our task was to effectively capture this normal activity on film.

Filming of the Lesson

The challenge in filming the lesson was in relating my somewhat incomplete vision of the final product to the CAET staff. The staff had to then translate this vision to the IMS staff in charge of filming the lesson. At this point the CAET staff assumed the role of translator. That is, they translated my vision into a technological plan which included the number (2), type, function (wide angle vs. close-up), and proper placement of the cameras and microphones, the room arrangement, and lighting considerations. This process did not remove me from the picture but required the CAET staff to continually translate for me the outcome of a particular decision to see if it would adversely alter my vision of the final product.

The Editing Process

There were four phases to the editing process. Phase one involved the initial rough edits I recommended. This process required the negotiation of editing considerations with the CAET staff. That is, CAET staff had to provide instruction as to considerations to make while viewing the rough footage: camera focused?; camera moving?; position of key people at the time of a cut from wide angle to close-up, or vice versa. This changed my focus from content specific to considering the visual and audio clarity of the video image. Phase two involved the CAET staff fine tuning the rough edits which I recommended. Phase three brought the CAET staff, IMS staff, and myself together to create the final video product. The final edit sheets drafted by CAET were used as a guide in creating the final video. However, further negotiation was needed in determining titles, length and type of dissolves, credits, and cuts needed because of time constraints.

Once the final video version was intact we were faced with the challenge of adding the narration. Our goal was to preserve the natural feel of the video therefore we wanted to avoid writing the narration. In the interim I used the videotape version of the lesson in elementary and secondary mathematics methods courses to receive student feedback. The decision was made to have each student write three questions that they would like to ask the classroom teacher in the video. These questions were compiled and sent to the teacher. The teacher organized the questions by common themes and drafted responses. The CAET staff arranged for the teacher to come into the studio to film his responses. Phase four was a collaborative effort between CAET staff, IMS, and myself in choosing the audio clips and the placement of those clips to enhance the visual image.

Interactive lessons

The final phase of this project is the negotiation of the lessons. At this time the lessons will focus on providing the user with opportunities to examine the role of teacher and student in creating a "safe" problem solving environment. The user will be given opportunities to focus on the teacher's role as facilitator, infer the mathematical understandings of certain students, and develop questions they would ask as the teacher in a similar classroom.

Conclusion

It is impossible to discuss the negotiation of the task in both mathematical problem solving episodes and in developing interactive multimedia materials without discussing the collaborative efforts of the key players. It is also impossible to discuss collaborative problem solving without discussing the ongoing negotiation of the task and solution between the players. The challenge is to effectively use the strengths of the key players whether it is in developing viable solutions to mathematical problems or in developing powerful multimedia lessons which will ultimately impact instruction in mathematics classrooms.

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The Evolution of Videodisc and Technology Use for an Educational Psychology Course

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Different types of technology are used in universities to provide provocative learning experiences for students and to teach knowledge and skills. Interactive videodiscs are a relatively new addition and are valuable in that they provide the rich visuals of a videotape with the programmable features of a computer. With interactive videodiscs as a teaching tool, instructors can program a variety of situations and tasks for students to perform within a realistic context thus providing opportunities for situating learning in an environment which cannot be provided with texts or lecture alone.

The Center for Applied Educational Technology (CAET) evolved from a College of Education recognition that technology can create new possibilities for reform in preservice teacher education. Originally designated the Videodisc Project, CAET has grown from a position of exclusive developer of videodisc-based multimedia materials targeted for implementation in undergraduate core courses to a multi-level support team providing information, instruction, feedback, technology expertise, and moral support to faculty members who are creating and implementing their own innovative multimedia presentations.

We work at an urban university, which serves a predominantly white student body. Kathleen is assistant to the director of the Center for Applied Educational Technology and lynne is an assistant professor who has been responsible for the planning and implementation of the educational psychology course for all students going through a certification program in the College of Education. It is through this particular course that our work at this university has merged. The story we are going to tell in this paper is about how technology has transformed the educational experience offered to the education students, and how it has transformed our professional lives.

Kathleen: I joined the then fledgling Center for Applied Educational Technology in 1989 as Assistant to the Director. My background is in English and reading education, and my job was initially defined as "content expert" in the development of a series of multimedia databases for use in a Reading Foundations course. Essentially, conception of the multimedia databases broke ground for what was to become a long-term College of Education commitment to instructional technology.

Although limited in their experiences with the technology, members of the reading faculty envisioned videodiscs as a way of helping preservice teachers translate textbook theory into actual classroom practice. The multimedia databases would provide connections among the text materials, videos of local teachers using the methodologies described in text, and reflective comments provided by these classroom practitioners. The videodisc/Macintosh computer connection would offer flexibility and control over presentations in whole class, small group, and laboratory settings. Because of their limited experience with the technology, including use of the Macintosh interface, faculty involvement in the development of these initial database materials was limited to content, and the CAET Director and I took on the roles of producers, directors, talent scouts, video editors, programmers, writers, equipment transporters, lab directors, and faculty/technology liaisons (Abate & Benghiat, 1993).

lynne: I am constantly trying to provide opportunities to prepare our preservice teachers for the multiple realities facing teachers today. As one of the teachers of the first pair of courses in the preservice education program which has a field component, I am left trying to help students make sense of their observations and experiences. However, following Vygotsky's (1978) perspective of knowledge construction, I believe it is important to provide my students with opportunities to observe teaching and learning situations which they can then discuss in order to make sense out of what they have seen and how it fits with what they are learning from text and lecture. In order to provide a focal point for informed discussion, I have turned to the use of videodisc technology.

I became acquainted with Center for Applied Educational Technology in the Fall quarter of 1990, but, as a new professor, just learning all the intricacies of university professor life (or nonlife as many would attest) I did not attempt to use the materials that I was actively viewing and investigating. Over the course of that first year, I looked at the videodiscs that were available for use, with an eye for how they may be used in my course. It wasn't until the second year that I sat down with the CAET director and actually put together a Supercard program with two of the videodiscs in order to bring them to my class and show segments of the lessons to illustrate the theories or methods in practice.

As I used the materials available from Center, and became convinced of its value for me, I became curious as to why more faculty were not using the materials. When we would get together to plan how I would be using the materials in my classes, the Director and I discussed the problem of other faculty not making use of this opportunity. In order to "give something back" to the project, I developed a survey to find out from the faculty who were involved in the core courses of our certification program why they were not using the equipment more extensively. The results of this survey indicated that time and knowledge of computers were the main obstacles (Hannah & Abate, 1992-93).

Kathleen: In a three-year period we developed nine multi-media databases, and as their use increased, two distinct patterns began to emerge. First, the most commonly used feature of the multimedia databases was the video presenter which enabled an instructor to preselect segments of the classroom video and customize a presentation to fit small and large group discussion formats (Abate & Hannah, 1994). Second, word about the videodiscs and the presenter utility spread, and faculty members outside of the reading faculty began to see them as rich instructional resources and to tailor them to their lecture/discussions. As these events were occurring, the comfort level of faculty with the technology began to increase, and a new crop of computer literate faculty members expressed an eagerness to take a hands-on approach to their classroom videodisc presentations. As more faculty members began to articulate their needs, an easy to use, stand-alone version of the database video presenter was developed. Entitled "Simple Controller", this Hypercard stack provides the maximum ease in the creation and use of videodisc presentations (Abate & Hannah, 1994). Another controller format offers the option of sending videodisc segments to videotape, creating a presentation from multiple videodiscs. Acceptance increased, and now more faculty members were using the technology. It was time to step back from our roles as producer/directors and become facilitators helping faculty to take charge of developing videodiscs tailored to the needs of their specific courses.

lynne: As a Macintosh user, I was very comfortable with the computer equipment and developing the video presenter programs. At the beginning of every quarter, I automatically planned for where in my course I would be bringing the equipment to class and which videodiscs I would be using. At the same time I was becoming more comfortable, more videodiscs were becoming available from CAET, thus I began using the technology more frequently during my course. Bugs in the system (human, not computer) did lead to problems in using the equipment. For instance, the initial program which had been developed was in a Supercard format, and over the course of time, CAET switched to a Hypercard application format (see above). Twice, my diskette with the program for running the videodisc presenter, did not work because Supercard had been removed from the hard drive of the computer available for transport to classrooms. Had I been less comfortable with the equipment as many of my colleagues reported (Hannah & Abate, 1992-93), I would have been unnerved by this problem. As it was, in both cases, personnel from the CAET were on hand to provide me with the materials I needed, while I continued to teach my course. What does this say about my planning ahead?

I became very adept at using the videodisc presenter in my large (90 student) lecture course. I also developed ways to use it in my smaller classes (20-30 students), where more discussion could be elicited from the students, and more segments could be viewed and discussed. The ability to use the materials for more discussion met my desires to provide opportunities for my students to observe teaching and then discuss what they saw and how they were understanding it. In this way, my instruction became grounded in real life situations which all the students observed and could then discuss.

Kathleen: The logistics for using the equipment in the class requires transportation and sometimes assembly of a cart containing a computer, videodisc or videotape player, and frequently a monitor or video projector, LCD display, and a speaker, in addition to a cumbersome mass of cables. In-class video monitors lighten the equipment load but call for connecting cables and produce lower quality video image. The advent of Macintosh Powerbooks has made equipment more portable, and the availability of appropriate equipment from the University wide Instructional Media Services provides unlimited access to VCRs, videodisc players, and monitors.

lynne: With a growing awareness of the value of this experience of my students, and with an invitation by the

CAET Director to develop a videodisc for my course, I started going through all of the videotape footage that had been shot over the six years the Center had been operating. It was during this experience that the problem of time to develop the materials (Hannah & Abate, 1992-93) became a reality for me.

I had not realized the depth of this commitment until I got into it. Watching over 100 hours of videotape footage, looking for segments which would illustrate concepts I teach in my Educational Psychology course, was difficult, even painful. My respect for the CAET staff has increased immensely as a result of this experience. However, the time was well spent as I became very knowledgeable about what information we had available for use in my classes. As I watched the classes on camera that had become part of our library, I was excited about all of the possibilities that opened up for my students.

I was afforded the opportunity to also take the pieces of the different classrooms and watch how they were put together in the editing room. As a participant in this process, I got to decide where we would move from one camera to another and how we would put pieces together to make a story that could help my students understand teaching and learning. Again, I became more aware of the work that had gone in to making the videodiscs I had used in the past. Because of this knowledge, I am better able to explain to my students what they are actually seeing, and to assure them that what they are seeing is more truth than what they see on television.

As a result of this work, I now have two videodiscs with several different segments which help to illustrate many of the different components involved in understanding educational psychology. I have used many of these segments this past fall quarter. I am currently investigating how my students perceive the value of these "videodisc observation opportunities."

Kathleen: Video production can be an arduous task, with many "magic moments" in a classroom ending up on the proverbial cutting room floor because a child stood up and blocked the camera or the camera got to the action too late. Editing video to come up with exactly the right segment to illustrate a point can entail wading through hours of raw footage. Audio is another element that must be considered. A segment that is visually ideal can be useless if there is an audio problem. Background noise can obliterate a priceless student response. And there is nothing more frustrating than exemplary group work that is inaudible because the students are doing exactly what they are accustomed to doing in groups, modulating their voices so they do not interfere with other groups in the room.

There really is no way to describe the editing process to faculty members, no way to instruct them, or help them through the frustrations or lessen the time involved. Also, there is no appropriate preparation for the "punchy stage" in which little sense can be made of anything you view. Providing moral support is essential, however, and there is a great deal of satisfaction in having collaborators to share anecdotes about the process with and who understand why I am bleary-eyed and inarticulate, at best, after editing sessions. In the final analysis, the frustrations of the process are a small price to pay for the finished product. Professionally produced simulations might be less vexing to create, but the value of showing undergraduate education students real teachers in natural settings has been proven. And faculty involvement in the total process is truly the most effective realization of the Center for Applied Technology's potential.

lynne: I feel fortunate to have the Center for Applied Educational Technology, which is available to improve the quality of educational experiences we offer our preservice teachers. With the help of the CAET personnel I have prepared a videodisc for my students which allows me to provide observation opportunities for my students. With mentoring from CAET personnel, my participation has gone from that of an infrequent user, to investigator, to that of a developer of materials specifically for my class. My use of the material has increased dramatically and based upon verbal and written feedback, my students find the use of videodisc presentations very valuable. Without experimental evidence to back up my statements, I can only say that the quality of discussions seems to have improved with the use of the materials. Students actively discuss what they are seeing and how it relates to the theories we are discussing in class. Because they are observing the same classroom experience, I find that the discussions we have are focused on the educational concepts and content, rather than descriptions of a field observation that other students were not present to witness. The next step is to document the effectiveness of these materials in qualitative measures of my students' understanding of educational psychology concepts in particular and teaching and learning in general.

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Flexibility is the Key to Video-Based Classroom Management Presentations

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During the first five years of a yearly Teacher Induction Program administered by the Cleveland State University College of Education (COE), 248 beginning K-12 teachers completed problem inventory forms at biweekly sessions. Completion of the forms required assigning professional problems to the following six categories: classroom management; instructional strategies; organization/planning; interpersonal problems; home/school/parents; and administration/extracurricular. Originally conceived as a method for providing planning assistance to the Program faculty, the 1,367 inventories collected over the five-year period yielded telling information about the issues that most trouble novice teachers, issues that often impede their professional success.

For all beginning teachers represented, management or discipline problems of behavior that interfered with individual achievement, group process, teacher or school rules, and teacher control, represented the most frequent and most troublesome issues. Management problems were related in 41.6% of the 309 middle school inventories submitted, 40.6% of the 431 secondary inventories, and 30 % of the 627 elementary inventories (Frew, 1994). Results of the Problem Inventory study are corroborated by anecdotal information provided by COE practicum and student teaching supervisors who visit and evaluate preservice teachers during these culminating field assignments. Although COE students recognize that classroom management is an integral part of any instructional plan and profess admiration for the management techniques used by master teachers they observe in the field, there appears to be a significant gap between what they understand and what they are able to translate into successful classroom practice. Often their responses to behavior issues are reactive rather than proactive, with little real instruction taking place during these incidents, and the best result being a short-term band aid effect.

Identifying a Solution

Targeting practicum and student teaching seminars as two appropriate environments for addressing issues of classroom management was the result of a number of years of investigation and discussion. Action on the part of the College of Education Center for Applied Educational Technology (CAET) was directly linked to a call from the Induction Program faculty for preservice teacher educators to consider classroom management as an integral part of their students' instruction in lesson planning and implementation (Frew, 1994). As part of its mission, CAET is to provide instructional technology solutions for addressing such issues. A decision was made to collaborate with the COE Interim Director of Field Services, Judy Finnegan, in this endeavor. Ms. Finnegan, a recognized expert in classroom management, provided lecture and small group discussion support in the Induction Program.

Initially, it was thought that videodisc and videotape materials would be produced for a Behavior Management course that Ms. Finnegan was teaching. However, this course is only required for Special Education Majors and is an elective for other undergraduate education students. Many Elementary and Secondary Education students satisfactorily complete the requirements for student teaching without course work specifically dedicated to management techniques. Recent reorganization of Undergraduate Core Courses in the College has provided for integration of classroom management in initial curriculum and planning courses, and at this level a foundation for understanding is built. However, the preservice teachers have little opportunity to think about classroom management as an integral part of a daily curriculum and to practice management skills on a regular basis. It is in the final field assignments of practicum and student teaching, then, that these skills must be employed, analyzed, and refined to ensure these aspiring teachers' professional futures. Therefore, it was ultimately decided that the ideal contexts for looking at classroom management as consistent component of successful lesson planning and implementation are the practicum and student teaching seminars; small, non threatening, discussion-based meetings of practicum students and student teachers conducted by the field supervisors that they share. These meetings are designed to address all common issues of interest and concern that occur in the field and to provide a forum for students as they reflect upon their teaching. Because seminar formats vary significantly based on the needs of the students and the teaching styles of the supervisors, it was also decided to develop materials that would provide for the maximum flexibility in presentation.

Creating Flexible Multimedia Materials

As a starting point, Ms. Finnegan developed a Behavior Management Checklist that categorized (Expected Behaviors Established, Methods of Reinforcement, Types of Reinforcers for Appropriate Behavior, Lesson Implementation/Delivery, Other Established Procedures) 28 teacher behaviors that could be observed as integral components of a successfully planned and implemented lesson. Ms. Finnegan's experience and expertise in the field led to the identification of a number of master teachers in the Greater Cleveland area who integrated these management procedures into rich, meaningful lessons on a consistent daily basis. Two of these teachers, a first grade teacher and a fifth grade teacher, were videotaped, and plans proceeded to use the management checklist and the video materials in the development of flexible multimedia tools for field supervisors to use in the small,, discussion-based seminar environment.

The videotapes were edited to maintain the integrity of the linear lessons (first grade reading and fifth grade small groups in science) and also to show multiple examples of each point on the Checklist. A primary goal of video production was to emphasize classroom management as a component of lesson success in real classrooms. Thus, alternative possibilities of creating simulations and letting students chose and discuss appropriate management techniques were put on hold. Instead, it was decided to provide supervisors with multimedia tools that would enable them to comfortably take the stance of mentors and facilitators as they "entered" videotaped classrooms with their seminar students and explored the nuances and subtleties of management techniques the master teachers employ so naturally. In addition, it was hoped that the presentations would be an impetus for student reflection upon their own classroom management.

To maximize potential use of the video materials, both videotapes and videodiscs were produced. Segments of the first grade videodisc were selected to illustrate each point in the Management Checklist, and a Macintosh-controlled video presentation was created using a HyperCard Stack titled Simple Controller. The Simple Controller, developed by the CAET director, is a flexible and easy-to-use tool for customizing video presentations that can become the catalyst for small and large group discussions. Briefly, each card of the Simple Controller stack holds six video buttons, six start frame fields, six end frame fields, and six fields for entering segment descriptions. Control buttons similar to those on a VCR remote control run along the bottom of each card, providing the means for identifying and isolating video segments to be used. To view each segment, the user simply clicks the mouse on the video buttons, and the segment plays (Abate & Hannah, 1994).

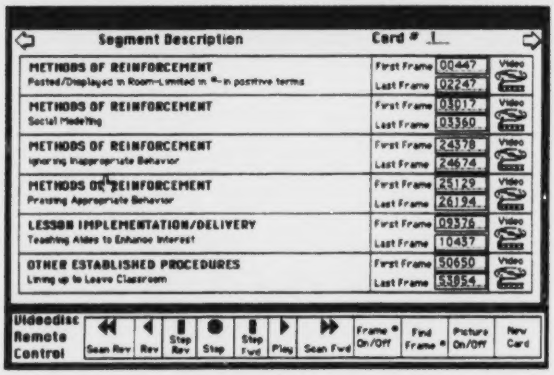
Implementation With Ease

The video and the Management Checklist Controller were introduced to the supervisors along with two additional presentation options. One option is the use of the Simple Controller to create individual video presentations tailored to the specific needs of the students in each seminar group (See Figure 1). Because some supervisors are more at ease with videotape, a second option is a HyperCard stack that enables the user to send video segments to videotape in a format identical to that of the Simple Controller. Complete CAET support is available with both controller options because of the varying degrees of comfort with the technology within the supervisor group.

Enthusiastic acceptance of the materials was immediate, with introduction of the materials in seminars now underway. The Simple Controller videotape option has been used to create a custom presentation for secondary student teachers who are grappling with group management. Segments of the fifth grade video were isolated for this purpose. Conversations with individual supervisors indicated that the flexible modes of presentation and the fact that videos were produced in real classrooms were the most important factors in making the materials useful in providing preservice teachers with a direct connection between the techniques of classroom management and making these techniques an integral part of successful lesson planning and implementation.

Looking to the Future

Supervisor feedback has already led to plans for the production of two additional videos, one for exclusive use in student teaching seminars and another exclusively for secondary preservice teachers. An additional controller modification has also been suggested that would allow seminar students, after viewing the video on videodisc, to review the lesson with the purpose of identifying and isolating segments that illustrate points on the Checklist. Future development possibilities include providing a means for individual students to use the Checklist/video connection in a lab setting, and creating specific situation simulations to reinforce the real classroom lessons and enable students to practice making sometimes necessary spur of the moment decisions. Ultimate success of materials will be found, however, in the professional success of the preservice teachers as they complete their first year of teaching.



Segment Description	Card # 1	
METHODS OF REINFORCEMENT Posted/Displayed in Room-Limited in #-in positive terms	First Frame	00447
	Last Frame	02247
METHODS OF REINFORCEMENT Social Modeling	First Frame	03017
	Last Frame	03360
METHODS OF REINFORCEMENT Ignoring Inappropriate Behavior	First Frame	24378
	Last Frame	24674
METHODS OF REINFORCEMENT Praising Appropriate Behavior	First Frame	25129
	Last Frame	26194
LESSON IMPLEMENTATION/DELIVERY Teaching Aides to Enhance Interest	First Frame	09376
	Last Frame	10437
OTHER ESTABLISHED PROCEDURES Lining up to Leave Classroom	First Frame	50650
	Last Frame	53854

Figure 1. Classroom Management Controller Example

Summary

Classroom management issues are recognized as the most troublesome for beginning teachers and are often the key to these novices' professional success or failure. To address this problem, the Undergraduate Teacher Education Program in the College of Education at Cleveland State University is approaching classroom management as part of daily planning and instruction. Multimedia materials that center around videotapes of real teachers in natural settings employing management techniques as part of successful lessons have been developed for use in practicum and student teaching seminars. These materials are flexible and easy to use, accommodating the varying technical abilities and teaching styles of seminar supervisors, and the specific needs of students.

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Helping Teachers Implement Interactive Multimedia: A Case Study of the Use of Encarta in the Classroom

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Multimedia technology has presented teachers with an interesting dilemma: the richness of information in multimedia courseware cannot be adequately accessed and processed by all students. Part of the problem lies in the fact that hypermedia (the base for much of multimedia) was initially developed for information storage and retrieval, not teaching (Locatis, Letourneau & Banvard (1989). The application to learning environments is more complicated than just information manipulation. The open navigational possibilities in interactive multimedia can cause location confusion, unsystematic searching, and inconsistent learning for many users (Welsh, Murphy, Duffy, & Goodrum, 1992). In addition, there is confusion as to what interactivity really means and under what circumstances it is helpful (Baker-Albaugh, 1993).

Many teachers also find the complexity of multimedia products overwhelming and difficult to use as support for the curriculum. The impending wide-spread adoption of CD-ROM technology in the schools heightens the need to anticipate use of this technology in the curriculum. The people who deliver the curriculum, the teachers, need to be trained in the selection and implementation of multimedia so they can effectively use the technology for instruction and support of instruction.

This paper describes recommendations for teacher training on the implementation of a multimedia encyclopedia. Recommendations are based on the results of a study of sixth grade students and their ways of navigating information while using Encarta '94 (Microsoft, 1993) a CD-ROM encyclopedia.

The Study

The purpose of the study was to gather information that will help teachers prepare their students for using interactive multimedia and to make recommendations for in-service and pre-service teacher training.

The study took place at a suburban central Ohio private K-12 school serving approximately 570 students. The school was selected because of its commitment to the use and implementation of technology. A novelty effect was avoided by selecting a school where participants had substantial experience with computer technology. Most students either have computers at home or have been using computers at school; computers are a subject of instruction at all grade levels. In addition to avoiding a novelty effect, examining the experience and feedback of experienced users provided critical information for the training of new users.

Participants

Participants of the study were 3 sixth-grade science classes. Of the 59 students, 30 students were boys, and 29 students were girls. Other participants included the two science teachers, two librarians and a library aide.

The Students.

The students were given two types of assessments prior to the use of Encarta: The Group Embedded Figures Test (Witkin, Oltman, Raskin, & Karp, 1971) and the Educational Technology Predisposition Assessment (Scherer, McKee & Young, 1991). The data from these tests provided important perceptual and attitudinal information about the students. The students had FI/FD scores from 1 to 18. The median was 9. Even distribution of FI/FD scores enabled three divisions of field dependence groups for examining correlations.

Table 1.
FI/FD Ranges by Sex.

		FI/FD Range	
Group	FI/FD 1-6	FI/FD 7-12	FI/FD 13-18
Males	7	13	10
Females	10	12	7

Note. Median (both groups) = 9.

The portion of the ETPA used for technology predisposition analysis was the PERSON questionnaire, which indicated personal incentives or disincentives for the use of a specific technology.

Table 2.
Technology Predisposition Scores.

Group	Average Score
Males	6.8
Females	6.9

Note. *Technology Predisposition Score was calculated by dividing the number of incentives (IN) for use by disincentives (DI) for each student. Students selected self-descriptive items from 18 IN and DI items that I had chosen from the original thirty of the PERSON section. An inter-rater reliability test of selected incentives and disincentives yielded a rating of 86.7 for incentives and a rating of 91.1 for disincentives.*

The school's librarians, Kathy and Laura, said in an interview that this class has had extensive experience with CD-ROM's. Laura had this class conduct an evaluation last year of the newly acquired CD-ROM collection. Their assignment was to select and evaluate 3 CD-ROM's. They were given a handout that prompted the students for the following observations: Did they understand the instructions (could they navigate)? Was the information available in other electronic forms, e.g. did they need specific or general information sources? What did they like? What didn't they like?

The Teachers.

Although both teachers, Maureen and Mike, used computers at home and at school, neither had used CD-ROM's with their classes or on their own. Having taught for over 10 years, Maureen elected to be part of the study because she wanted to learn about CD-ROM technology and be able to use it in her teaching. Mike is in his second year of teaching 8th grade math, and this is his first year teaching sixth grade science. He recently purchased a computer for home and took time at school to try out Encarta.

The Librarians.

The library is staffed by two full time people, Kathy and Laura. A part-time library aide also works there. Laura's goal for the middle school students is to help them become independent information gatherers. This past year was the first that the CD-ROM hardware and software were available in the library. Kathy and Laura were initially discouraged with the realization that they wouldn't be able to apply one of the basic rules of librarianship: librarians should know their collection. They tried to become acquainted with the content and organization of the CD-ROM's, but they found the information to be too condensed and too complex for their limited time. They decided instead to make the CD-ROM's accessible for free exploration by the students and to seek feedback from them.

Method

I met with the teachers to discuss the selection of software to be used in the study prior to the data gathering in September, 1994.. After discussion of curriculum and instructional objectives, we decided that students would use the multimedia encyclopedia Encarta '94. The students would use Encarta to gather information for a report on the solar system. Topics could include the lunar phases, exploration of the Moon, the Earth's position in the universe, etc. The students' final products were to be posters on which they would display information about the historical development of scientific discoveries about their topic. The pedagogical basis of the assignment was based upon a study by Ben-Zvi, Eylon, & Silberstein (1986), as quoted by Eylon and Linn (1988), who found that an historical approach to concept development helped students link related ideas and recognize misconceptions.

In cooperation with the classroom teachers, I conducted two training sessions with the students. First, I helped the teachers in a lesson that detailed the content and format of their solar system project. I had prepared a poster on the topic, "How Do We Know the Earth Is Round?" The poster displayed a one page report and several pictures, printed from Encarta, detailing ancient and modern beliefs about the Earth's shape. I also passed out an assignment sheet that the teachers and I had prepared. The second training session involved the basics of using Encarta. The students came to the library where the CD-ROM stations were, and they watched as I demonstrated Encarta with the help of overhead transparencies of major menus. I had Encarta running on all four stations and had a student at each station following my demonstration.

The next week I observed all the students as they worked in pairs at the stations. The students came to the library in small groups to work at one of the CD-ROM stations. At the librarians' suggestion, girls were paired with girls, and boys were paired with boys. One of the classroom teachers agreed with this pairing because of the dominant nature of the boys at the computers.

During the students' use of Encarta, I observed, instructed, and made notes about the students' questions, problems, habits, and search techniques. The teachers were either in the library or in the classroom, depending upon the students' project progress. For sake of the study, we limited CD-ROM use to Encarta, but we encouraged them to use other print and non-print sources. The Encarta-only policy did cause frustration with a few of the more computer-savy students who were aware of other CD-ROM's and wanted to use them.

On the day that the students' final projects were due, I administered a Post Encarta Survey that asked about preferred search strategies, learning strategies, attitude toward CD-ROM technology, and recommendations for use. Semi-structured interviews of the teachers' and librarians' CD-ROM experience concluded the data gathering.

Results

Data analysis included examination of the navigation styles of the students as well as which navigation facilitators were used by the students. Students', teachers', and librarians' perceptions of training needed for the use of Encarta was documented and analyzed for learning style and technology interactions.

The Students

I observed two distinct styles of gathering information. The first type of information gatherer I observed was the "harvester." This student was concerned with getting as much information as possible and didn't want to miss any opportunities in the time allotted. Anything that remotely referred to the desired topic was printed, whether the information was in the form of graphics, pictures or text. This student would decide later which information was appropriate for the report. Harvesting was enhanced by the multimedia technology because of the ease of access and of printing information. The second type of information gatherer was more thoughtful, more of a "picker" who looked at each selection carefully before deciding which information should be printed. This student came away with information that was more directly related to what the student would be writing. Since each student pair had twenty minutes per session, time did not seem to be a factor in style. Both harvesters and pickers came back for more information at other sessions, but no differences in return patterns were observed between these two groups.

Another theme I observed regarded collaboration models. As a rule, the girls collaborated more often and with more deliberation than did the boys. Upon entering the library, the boys would usually race to the stations to see who could get the commander's chair, that is, the one in front of the keyboard. If a student did not get the commander's chair, then the next tool in line of importance was the mouse. The student who had control of the mouse was really in control of the information search. Some strained arm reaching was used in order to gain control over the person who sat in the commander's chair! The girls, however, were generally more cooperative. They discussed who would go first, sometimes at the risk of not getting started. Usually the girl whose information was being sought would either be given the commander's chair or be given the mouse. There was a willingness to share control. One girl, however, wanted to work alone.

At the end of the project, I administered a Post Encarta Survey. When asked to rank order the learning aids considered to be most helpful, both the boys and girls considered "Using Encarta" the most helpful and "Having Expert Help" the next most helpful. Females slightly preferred Having Expert Help more than the boys who slightly favored Using Encarta.

The data concerning the least helpful learning aids were skewed because one response depended upon family ownership of Encarta, and most of the students do not have Encarta at home. Therefore, the next level was examined. At this level, the males were strongly opposed to working with a classmate and checked "Classmate" as the next least helpful learning aid twice as many times as did the girls. The girls disliked the overhead transparencies as a learning aid more than did the boys. FI/FD was not found to be a factor.

Other interesting data emerged from graphing the most liked and least liked about Encarta by FI/FD. Because the number of responses was different for each FI/FD category, the percentage of responses for each item within an FI/FD group was calculated. The graph shows that the amount of available information was most valued by the field independent students. When sorted by sex, the boys were much more impressed with ease of use than the females.

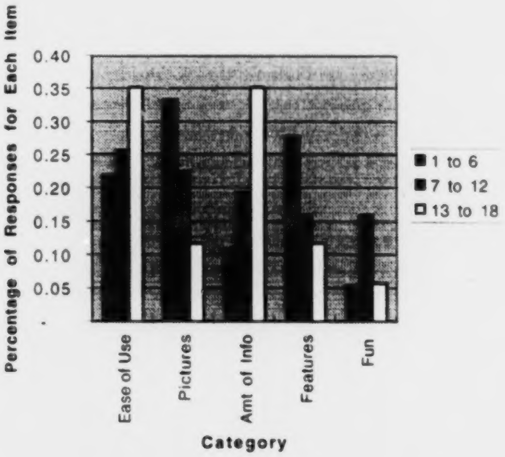

Figure 1. Most Liked About Encarta by FI/FD.

In the data analysis of "Least Liked About Encarta," field dependent students were mostly concerned about reading level and specific features of Encarta that they didn't like. Lack of independence, or having to work with a partner, was a concern of the field independent group.

These results coincided with the data that were correlated by sex. Only boys mentioned dislike for working with a partner, and only girls mentioned reading level as a concern.

The question, "The librarian can help me the most by....," revealed strong sex-related differences. Again, boys wanted to be left alone but wanted a knowledgeable person nearby for help if needed. Girls, however, clearly wanted navigation help from the librarian. When sorted by FI/FD, 67% of the students in the 1-6 range selected navigation assistance as the best way librarians can help.

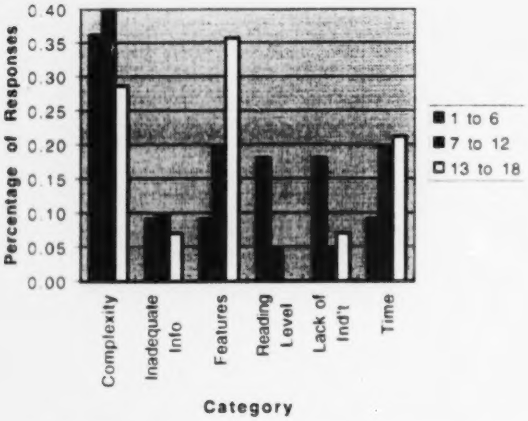

Figure 2. Least Liked About Encarta by FI/FD.

I also asked the students if they preferred getting information from a book than from a CD-ROM encyclopedia. Of the 59 students who responded, 8 students, all girls, said yes. Three of these eight students were the only ones of all the students to say they didn't think, or couldn't decide if, using a computer was fun or helpful.

In tallying the number of menu features used by the students, I found that the students generally used the features I had taught them. The most frequently circled items on the survey were (a) contents, (b) text print, (c) picture print, (d) menu, (e) text partial print, (f) photo icon, and (g) hot words.

From the Teachers' Perspective

The teachers were very positive about their students using Encarta as an information source. Mike and Maureen liked the way Encarta appealed to students with various learning styles.

The teachers also felt that the training sessions were helpful for the use of Encarta as well as for the quality of the students' final product. Although the students didn't particularly value the overhead transparencies, Maureen thought they served as good visual advance organizers. Like the students, however, the teachers agreed that using an application is the best way to learn it. The teachers also pointed out the improved quality of the posters over past projects. Both the contents and visual composition were better than past products. The gain in quality was due to three factors, they decided:

1. The model poster I created provided the students with a format.
2. The accessibility of pictures to print reduced the quantity of many hand-drawn pictures.
3. The accessibility of word processing and graphic titles gave the posters a more professional look.

From the Librarians' Perspective

When asked the question, "What are the ways that a teacher can constructively use the librarian when implementing CD-ROM's?," the librarians reponded with the following list of suggestions. Many of these suggestions apply regardless of the medium.

Before Going to the Library

1. Preview the CD-ROM's you think your students will use.
2. Have a notion of what other sources are available.
3. Ask the librarian about collection availability.
4. Plan your lesson with the librarian.

During the Library Visit

1. Stay with the class and conference with students.
2. Know the program well enough to help with navigation.
3. Help students with topic selection.

After Library Use

1. Share papers and projects to the librarians so the librarian can evaluate the type of help that is needed next time.
2. Provide the librarians with feedback about the library's collection, technical problems, the CD-ROM's usefulness and ease of use.
3. If planning was done together, evaluate the activity with the librarian.
4. If a topic is too difficult, remove it from next year's list.

Discussion

The data from the study show that there are three main concerns for teachers who are implementing technology in their instruction: (a) know how students respond to the task and to the technology, (b) know the technology, and (c) use the librarian. While acknowledging repeated evidence of male/female differences in technology use, teachers can help the boys be more cooperative and help the girls be more assertive. Teachers can be trained to be more sensitive to equitable access to technology. Education professors can encourage pre-service and in-service teachers' sensitivity to sex differences by having the teachers document male/female technology use patterns in their own classrooms. In addition, teachers should explore the appeal multimedia has to children of different learning styles.

The students' responses also strongly indicate that teachers need to be knowledgeable about the technology being used. The teacher doesn't need to be all-knowing, just familiar with the technology, and willing to learn along with the student. A major principle in media use is to preview, preview, preview. And, as the librarians pointed out, teachers who work along side of their students steadily gain expertise about the technology at hand.

Another issue is the untapped resource of the librarian. Whether the CD-ROM station is in the library or the classroom, the librarian can provide useful guidance in the selection and implementation of CD-ROM technology. Librarians welcome the task of helping the teacher with topic and resource selection. Also, the librarians note that the brightest students always get the best topics. Teachers need to make sure slower paced students get information rich topics. Librarians are also certified teachers, and they have the expertise to help teachers plan library-related lessons.

What about training the teacher for the implementation of a CD-ROM encyclopedia such as Encarta? What should the teacher know and be able to do? Fundamentals include (a) knowledge that a CD-ROM encyclopedia is a unique resource that has similarities to and differences from books, (b) techniques for management of multimedia use such as training a small group of students to be "experts" who, in turn, teach the other students, (c) basic navigation procedures, and (d) program features that may cause problems because of a student's developmental stage or learning style.

The students likeEncarta, especially the plethora of pictures, animation and sounds, but they point out some features that teachers need to address. First of all, it is very easy to accidently exit from the program. The students become confused between the words "close" and "exit." In addition, students can print a portion of an article, but the procedure is laborious. The students also mention a problem that is actually a function of the depth of information in Encarta—there are "too many buttons to push...too many choices." When they select multimedia software, teachers will have to evaluate the trade-off between amount of information and ease of use.

Conclusion

With appropriate experience and training, teachers can provide their students with the educational richness of a CD-ROM encyclopedia while addressing the medium's challenges of access and complexity. Further research needs to continue across grade levels and types of interactive multimedia so teachers have grounded advice in the application of this technology to their instruction.

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Teacher Talk: Capturing Innovative Teacher Voices in a Multimedia Internet Environment

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To keep the flow between teacher preparation and teacher practice as seamless as possible, emerging teachers need to both absorb classroom experience and listen to the sage advice of teachers in the field. The need to learn from experienced classroom teachers increases as preservice teachers approach their student teaching assignments. Providing the opportunity for preservice teachers to hear innovative teachers talk about their trade is essential, yet this is often a difficult component to implement in teacher education programs.

Preservice teachers' insistence on practical tips for the classroom is well known to teacher educators. The philosophical underpinnings of their preparation are often shunned by preservice teachers in favor of the more "relevant" need to compile teaching tips and strategies to use when they get into the classroom. Helping preservice teachers to understand that teaching is not as simple as they may think presents a challenging task for teacher educators. Rodriguez (1993) asks pointedly, "Where do students get the impression that learning how to be a teacher can be packaged into easily transferable sets of classroom management routines, teaching strategies or learning-enhancing devices?" (p. 217).

Katz and Raths (1992) refer to a dilemma for teacher educators between an emphasis in coursework on the current versus the future needs of teacher candidates. The current needs, as perceived by candidates, are represented by the packaged, step-by-step teaching practices. The future needs are more complex and difficult to pursue, such as helping preservice teachers uncover their own beliefs and concerns, but will yield much greater returns in effective teaching and learning. Wilson (1990) echoes this, explaining that her students expect to learn recipes for teaching and feel cheated if they do not get them. Instead, Wilson engages preservice teachers in the arduous task of critically examining their own ingrained conceptions of the nature of teaching, learning, and knowing and relates these constructs to their future roles as educators.

These issues are directly related to the debate over theory versus practice in teacher education. This involves a balance between providing preservice teachers with knowledge of major theories and movements in education as well as pragmatic teaching strategies. The practical experiences are largely realized through field-based placements of classroom observations and student teaching. However, these field experiences have their limitations; students are only able to observe a few teachers. It is no surprise, then, that preservice teachers tend to see student teaching as the only beneficial experience in their education program, because it is entirely relevant to their future profession. This further exacerbates the incongruence between what is taught in education courses and what is learned in the field (Guyton & McIntyre, 1990). Despite the present situation, the theory/practice dilemma need not be an either/or proposition in teacher education. The practicing teacher can serve an important role while satisfying preservice teachers' needs to hear teaching tips "right from the horse's mouth," and to understand the issues teachers face in the classroom.

Historically, the linkage of preservice teachers with practitioners has been a natural and common one in the United States. Based on the apprenticeship model, teachers-to-be learned the trade from a mentor in the field. By the mid-1900s, laboratory schools served to provide preservice teachers with opportunities to work with students as a way to complement their own studies. This hands-on practice gradually changed with the development of student teaching and field placement experiences (Stallings & Kowalski, 1990). Despite the value of these efforts, each requires an enormous commitment of time and resources to adequately support it.

Recently there have been calls for innovative practitioners to play an increased role in the preparation of preservice teachers (Goodlad, 1990; Holmes, 1986; Nowicki, 1991), though options for providing a place for the practitioner in teacher education programs have been difficult to create. Professional Development Schools (PDS) have sought to build a more substantial school-university partnership aimed at improving education and better preparing teachers (Abdal-Haqq, 1992; Levine, 1988). Some teacher educators have found that bringing in practitioners as guest speakers in methods classes is enthusiastically received by preservice teachers. Whatever the approach, dialogue between future and veteran teachers is vital to the preparation of preservice teachers (Feiman–Nemser & Parker, 1990; Nowicki, 1991).

With the advent of new technologies and media, there are new ways in which preservice teachers can access innovative teachers' voices as they prepare for entering the field. This paper describes one such approach, *Teacher Talk*. In this paper, we will describe the content and the processes by which it was created and a preliminary evaluation of the impact *Teacher Talk* has on preservice teachers.

Teacher Talk

Teacher Talk gives practicing teachers more opportunities to reach out to preservice teachers, without the limitations of geography and time. Developed at the Center for Adolescent Studies at Indiana University, *Teacher Talk* is offered through three media: print, video, and the Internet. Beginning with a print format, *Teacher Talk* was created to provide a means of helping preservice teachers understand the emotional, social, and cognitive developmental needs of secondary students. This was accomplished through interviews with innovative teachers. The voices of practicing teachers were accessed by several means and then translated to the *Teacher Talk* publication for preservice teachers.

Process

In order to guide the development of the publication, an advisory board was created. The *Teacher Talk* Advisory Board consisted of the target population (preservice teachers), student teachers, and young, practicing teachers. This group served to advise on topic selection, help identify resources, write articles, and edit material. They were also supportive in distribution and in the evaluation processes. For example, one of our young teachers discovered a very effective book for first–year teachers. She wrote a book review of that book which was included in the second issue of *Teacher Talk*.

For teacher contributions, we initially talked to teachers with whom we had worked previously and later broadened nationally to include master teachers. Members of the Advisory Board and the Center staff all knew of teachers who had innovative, effective practices around the themes we were discussing. Those teachers were asked to contribute ideas or specific lesson plans in the area of interest. Often those teachers referred us to other teachers in their school districts or to colleagues nationally. We also made contacts with teachers through a number of ongoing research projects at Indiana University. Thus, we were able to identify examples of innovative practice nationally.

After the second edition, we tapped into several computer networks and lists. We posed the general question or theme raised in an issue of *Teacher Talk*, and teachers on these networks freely gave us advice and lesson plans. Often teachers that contacted us in this way had also published their ideas in one of the journals or other professional publications. Adaptations of those articles always included an interview with the teacher to authenticate the practice and to identify those elements that would be most relevant to preservice teachers.

Features

The print format of *Teacher Talk* is a brief four page publication enhanced with lively illustrations. Each issue focuses on a particular theme (see Table 1). In addition, a pullout, middle–page section called "Great Ideas!" provides some ready–to–use ideas for the classroom surrounding each issue's theme.

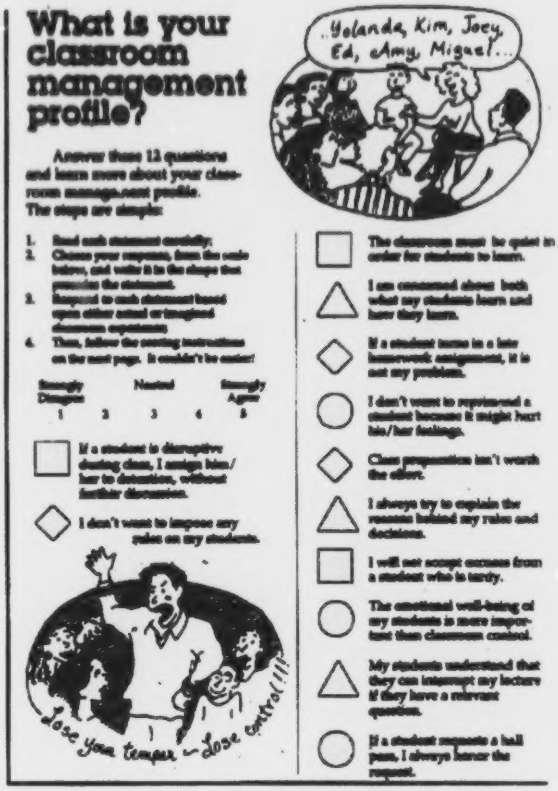
Initially, the Advisory Board created a long list noting types of articles that are often found in publications for teachers. These included interviews with teachers, ideas for lesson plans, ideas for unit plans, book reviews, program descriptions, information articles, quizzes, interviews with teachers, and resources for further information. Using the list created by the Advisory Board as a basis, we experimented with a number of different features in our initial issues of *Teacher Talk*. (Figures 1 and 2 show examples of two unique *Teacher Talk* features.) Each time we distributed an issue, we also included a reader evaluation form. This reader evaluation survey asked about the utility of various topics.

Lesson Plans - "Great Ideas!"

After the first issue, readers expressed a need for specific lesson plans to put into practice the ideas expressed in *Teacher Talk*. A one–page insert, included with each issue, contains four "Great Ideas!". Each "Great Idea!" details a classroom–tested lesson or unit plan. Topics for "Great Ideas!" include science experiments, activities for first day of classes, oral history, integrating art, and A.I.D.S. education.

Table 1. Description of *Teacher Talk* issues.

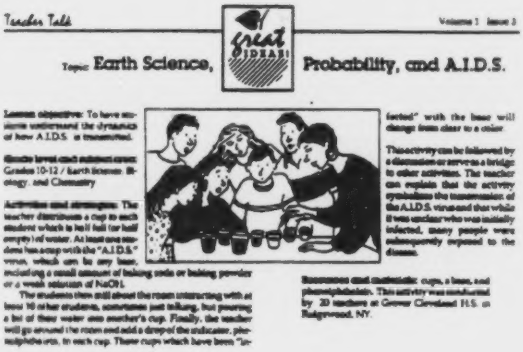
ISSUE	THEME	MEDIA	CONTENT
#1	Building Student–Teacher Rapport	Print, Internet	•Interviews with 3 classroom teachers about their strategies •Resources •Caring teachers: students' perspectives •Service learning
#2	Classroom Management	Print, Cartoons, Lesson Plans, Internet	•Assess your classroom management profile •Descriptions of 4 different styles •Book review – Wong & Wong, *The First Days of School* •Conflict mediation
#3	Sexuality in Schools	Print, Video, Cartoons, Lesson Plans, Internet	•Questions teens ask about sex •Assess your knowledge about teen sexuality •Dealing with sex issues in the classroom •School–based clinics •Educational programs for pregnant teens
#4	Education Outside the Classroom	Print, Cartoons, Internet, Lesson Plans	•Changes in the workforce •Global education •Service learning •School–business partnerships •Senior volunteers •Communications technology •Internet primer
#5	Diversity	Print, Cartoons, Internet, Lesson Plans	•Assess your knowledge of diversity issues •Characteristics of special populations •Strategies for success in diverse classrooms •T.E.S.A. •Resiliency
#6	Conflict in Schools	Print, Video, Internet, Cartoons, Lesson Plans	•What to expect •Strategies for dealing with conflict in classrooms, halls & on school grounds •Crisis management •Teaching about peace



What is your classroom management profile?

..Yolanda, Kim, Joey, Ed, Amy, Miguel!...
Strongly Disagree
Neutral
Strongly Agree
1
2
3
4
5
Lose your temper – Lose control!!!

Figure 1. Classroom management quiz.



Teacher Talk

Topic: Earth Science, Probability, and A.I.D.S.

great IDEAS!

Figure 2. Example of a lesson plan from the "Great Ideas!" section.

Teacher Talk Forum.

The video extension of *Teacher Talk* grew out of the need to provide views on controversial subjects from multiple perspectives. The first video was based on a panel discussion on sex education curricula for issue three. In the video, a group of educators shared their views on the

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purposes, rationale, and implementation of sex education curricula, as well as their views on how sexual issues arise in the secondary classrooms of today. The participating educators represented the spectrum of voices heard in the current debate about sex education. An edited version of this forum served to complement a print issue of *Teacher Talk* on the same topic.

The second *Teacher Talk* Forum focused on conflict resolution and violence prevention. The Forum served as the source of material for *Teacher Talk* issue six and a video. Secondary educators and administrators from middle and high schools gathered to discuss the topics. They came from urban, suburban, and rural school districts. The participants discussed the prevalence of conflict, strategies for addressing conflict, and examples of how to deal with specific situations that involved conflict.

Internet.

Once the success of *Teacher Talk* was established as a means of integrating teacher voices into preservice teacher education, we began to explore options for expanding the audience. As educators' access to the Internet increases, this information super–highway offers a medium for widespread communication. Through the World Wide Web, complete issues of *Teacher Talk*, including graphics and accompanying video became available to a wide audience. *Teacher Talk*'s address is:

http://education.indiana.edu/cas/tthmpg.html.

Evaluation

Method

As a preliminary evaluation of the impact of *Teacher Talk*, 57 preservice teachers, enrolled in a general methods course at a Midwestern university, completed a survey. The data were collected on two occasions, one week apart. During the intervening week, students were encouraged to read issue three of *Teacher Talk*. The issue focused on teen sexuality and the schools. The articles addressed topics such as: facts regarding teen sexuality, school–based clinics, a program for school–aged mothers, homophobia, sexuality curricula, A.I.D.S., and how to deal with sex issues in any classroom. Many of the articles were adapted from the transcript of the first *Teacher Talk* Forum.

Of the students who completed the survey, there were 41 females and 14 males, and their ages ranged from 19 years to 44 years. The students were representative of that university's preservice teacher population. The experimenters presented the survey at the beginning of a class session and allowed the preservice teachers 15 minutes to complete the survey. Participation was voluntary.

Students in three sections of the general methods class took a pre–test survey. Two sections were experimental (n = 39) and the third was the control section (n = 18). The experimental sections received one copy each of issue 3 of *Teacher Talk*. Preservice teachers were asked to read the publication outside of class time. The following week, students in the control and experimental sections completed a survey identical to the pre–test. These two sections were the experimental sections.

Instrument

The survey included 23 forced–choice questions. The preservice teachers responded on a 5–point Likert–type scale. These 23 items formed four sub–scales: attitudes, self–efficacy, knowledge, and comfort.

The first scale measured attitudes relating to sexuality with questions such as, "Teenagers should not engage in sexual intercourse." The second scale measured the preservice teachers' perceptions of self–efficacy when addressing circumstances relating to teen sexuality. An example of an item from this scale is the statement, "As a teacher, I can help a teenager who indicates that s/he may be gay." The third scale measured the preservice teachers' self–assessment of how knowledgeable they are of what to do in circumstances where teen sexuality is manifested. "I know what to say or do with a teen who is pregnant and is exploring options" is an example from this sub–scale. The fourth scale measured the preservice teachers' comfort when addressing situations that involve teen sexuality. An example of an item is, "How comfortable do you feel talking to teens about homophobic attitudes and behavior?" Table 2 indicates the number of items in each scale and the results of the reliability analysis.

The survey asked the preservice teachers if they had seen the publication prior to the evaluation. In addition, it asked the preservice teachers in the experimental condition how much of the publication they read after the initial survey. Based on the answers to these questions, responses from preservice teachers who had read the publication before (n = 9) were excluded from any further analysis. Also, responses from those teachers in the experimental condition who did not read the publication at all were excluded (n = 10). Three preservice teachers met both criteria. The result was three categories: true experimentals (n = 28), true controls (n = 13), and those who fit neither of the above (n = 16). The small number of teachers in the latter two categories precluded any further meaningful analysis. The remainder of the results, displayed in Table 2, come from the true experimental category.

Findings

As can be seen in Table 2, the results indicate a statistically significant increase in self–assessment of knowledge ($p < .05$). Additionally, there was an increase in attitudes and in comfort, with the latter change being significant at $p < .10$). The change in self–efficacy was in the opposite direction, but was not significant.

Table 2. Survey Scales, Reliability Analysis, and Mean Responses for True Experimental Condition (n=28).

Scale	Number of items	Alpha	Mean[1] (pre–test)	Mean[1] (post–test)	Two–tailed significance
Attitudes	4	0.5421	1.68	1.77	0.195
Self–efficacy	6	0.7449	2.87	2.79	0.278
Knowledge	5	0.7501	2.49	2.67	0.029*
Comfort	3	0.7138	2.19	2.34	0.069**

Note: [1] (Range = 1 to 5), * $p \leq .05$, and ** $p \leq .10$

Another effort to evaluate *Teacher Talk* relied upon reader responses to surveys enclosed in each issue. Some preservice teachers had comments on the utility and layout features of the publication as well as their overall reactions to it:

- It's interesting to consider teachers' experiences and solutions to problems.
- I feel that it has helpful insights. This is something I would like to continue receiving.
- I think this is an excellent publication! It has given me lots of useful information I can use in my classroom.
- The articles are really helpful and the layout of the publication is very easy to follow.
- I just wanted to say that I find Teacher Talk to be very informative and useful for secondary teachers. I have been impressed with the information provided and the design. I hope you continue to publish it.

In an effort to gain another perspective on the overall usefulness of *Teacher Talk*, teacher educators were interviewed. Among their comments were the following positive statements:

- Teacher Talk has several good things: Great Ideas! and thematic focus. It is a very worthwhile publication.
- Teacher Talk is impressive with the topics it covers and it is journalistic, as opposed to scholarly.
- Teacher Talk has potential as a common communication piece.

Conclusion

Though preservice teachers are exposed to knowledge of theory and practice in teacher preparation programs, they clearly desire and benefit from increased contact with innovative teachers. Veteran teachers, with their experience and wisdom, can assist preservice teachers as they prepare for their future roles in the classrooms. *Teacher Talk* uses multimedia to respond to the need to integrate the best classroom practices and the voices of master teachers into preservice teacher education. Initially through print and video formats and now through the Internet, educators have access to current ideas and innovative practice, centered around themes such as classroom management, diversity, and sexuality.

The evaluation of the *Teacher Talk* issue on sexuality has identified that this approach is effective in increasing both self-assessment knowledge and comfort level in preservice teachers. This demonstrates that *Teacher Talk*, a multimedia publication, responds to the needs of preservice teachers and can be a powerful intervention for increasing their knowledge base and expanding their sensitivity to issues in classroom practice. Via the Internet, teacher educators have easy access to this resource for personal use, as well as in their classrooms.

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Fidelity and Moral Authority: Ethical Issues in Videodisc Design

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The concern for improving the quality of university teaching has resulted in increased support for research that identifies characteristics of effective teaching and devises strategies to help post-secondary instructors implement these new schemes (See, for example, Common, 1987; Elrick, 1990; Menges, 1980). As one example of these activities, Campbell and Fishburne submitted a proposal to design and produce four Level I videodisc sides highlighting role models of exemplary post-secondary teaching to the University of Alberta's Committee for the Improvement of Teaching and Learning (CITL), now University Teaching Services (UTS), which was funded in 1991 and again in 1992.

Some of the well-known advantages of videodisc technology include portability, robustness, fast random access, programmability, and flexibility. Ironically, as the videotaping phase of the design process unfolded, a number of these very advantages posed ethical dilemmas for us as researchers/designers. The purpose of this paper is to explore some of these dilemmas in an attempt to emphasize the importance of an ethic of caring (Noddings, 1986) related to the design, production, and dissemination of public records of teaching.

Ethical Standards in Visual Anthropology

A long-established conversation in the discipline of visual anthropology (Becker, 1979; Bogdan and Biklen, 1982; Collier and Collier, 1986; Heider, 1976; Schaeffer, 1975) provided a starting place for our own questions. Ethical standards at research institutions, based on standards first elucidated by the American Anthropology Association, have focussed on issues of anonymity and confidentiality, informed consent, the rights of participants, concealment, and researcher competence[1]. While we agreed with the unassailability of these universal standards, we propose a broader view that recognizes a moral imperative in educational research (Eisner, 1988; Lincoln, 1988; Noddings, 1986) as it applies to videotaping the work of teachers in their classrooms. It becomes especially acute when we consider the use of videodisc as a dynamic medium that encourages its audience to construct their own meaning.

Many of the issues relating to the initial use of visual tools in anthropological research focused on still photography (Becker, 1979; Bogdan and Biklen, 1982; Collier and Collier, 1986), and involved questions of epistemology, validity, sampling, selection, and privacy of the subject. The concerns for the use of videotaping in research have focused on the mechanistic, the legal, and the epistemological. Heider (1976), however, extends ethical technological considerations related to understanding and classifying cultural events such as classroom teaching, one that we found of paramount importance in our work. He asks ethnographic film-makers to "be aware of the considerable responsibility which accompanies the license to study and to film" (p. 120). We take this to mean that we have an imperative to "anticipate the potential damage which a film might do to ...social and psychological welfare as well as to ... dignity and privacy" (p. 120). Since the video sequences on our videodisc will form a public visual database, we are aware that videotaping University classroom teaching has added professional risk for the participants since promotion and tenure decisions are partly based on teaching effectiveness, and this videodisc is a public record containing out-of-context portions of classroom teaching acts. The unedited master tapes may provide the greater danger in this case, as these visual records are stored for some years and are accessible as content to individuals completely unaware of their provenance.

At the outset, our initial concerns for maintaining ethical standards focused on negotiating entry and obtaining written consent. However, during and following our first classroom videotaping session, we realized that our rather instrumental concerns did not reflect the personal and professional impact of the process on both the designer/researchers and the participants. Our design story tells of our awakening (Eisner, 1991) to the tensions, controversies, and dilemmas that are lived as we engage in research *with* others. There are no obvious solutions to the dilemmas we have lived in this process, but we raise them here in terms of the "fidelity" (Noddings, 1986) owed to all individuals included in this project.

Ethical Tensions in Videodisc Design

We have identified a number of questions relating to the tensions and complexities of a videodisc design process involving classroom teaching. We anticipate others will emerge as design continues on hypercard stacks accompanying the videodisc and as we continue to try to bring together diverse cultures in a collaborative endeavor. This discussion takes place in a conceptual framework that examines issues of ideology, collaboration, and integrity.

Ideology

Considering the audience for research products, Lincoln (1988) raises questions of ontology, epistemology, power, legitimacy, and authority. She urges practitioners to consider knowledge as value-bound, contested, political, and open to disconfirmation or revocation. These issues asked whose *agenda* had direct bearing on design and production decisions and led to three related questions: a) What is effective teaching? b) How should teaching exemplars be identified? c) To whom are we accountable?

What is Effective Teaching?

We were to construct a view of *effective teaching* , which by our content design and production decisions reflected our personal ideologies and did not necessarily conform with the views of other stakeholders in this process. Fortunately, the nature of videodisc technology encourages accommodation of divergent views. Videodisc design, with its multiple layers of meaning, allowed both the exemplars and the designers the luxury of including remarkably different perspectives of Good Teaching. For example, we could reflect both the exemplar's practice visually, and the reframing of it with a second audio track used reflectively (by the exemplar) and analytically (by the narrator).

How Should Teaching Exemplars be Identified?

Initially we approached individuals who were formally recognized by peer-nominated awards for their teaching ability, but recognized that many more excellent teachers had not been publicly identified. One strategy was to advertise in the University of Alberta's official newspaper, the *Folio*.

Another dilemma arose in our selection of exemplars to reflect cultural, gender, and age diversity: How much should these factors influence our choice of exemplars? A demographically accurate selection would include a preponderance of older white males, but we felt it important to model an equitably-balanced population. In the end, however, the product really *did* represent the reality of academic demographics at the University of Alberta.

To Whom are We Accountable?

Because we were sponsored by the Fund for the Improvement of Teaching, we continually had to ask ourselves the extent to which our interpretation should reflect the values and belief systems of the institution. As well, we pondered our ethical responsibility to participants if asked to revise or report data, that is, videotaped classroom sequences, in a different format, for example in projects other than the project that was funded.

Collaboration

We framed our design process with the collaborative working principles identified by Clandinin and Connelly (1988): negotiation of entry and exit, judgment of practice, accepting the participant as both knower and partner in the construction of meaning, openness of purpose and interpretation, and multiple interpretations of text (in this case, the videodisc is the text). We were also guided in the instructional design process by a framework of fidelity and care requiring us to "... meet colleagues in genuine mutuality" (Noddings, 1986, p. 506). In practice, we designed a mutually constructed story of effective teaching emerging out of a collaborative conversation blending multiple voices and ideas.

Because we were committed to a collaboratively constructed story, we actively involved each participant in the design process. We began by inviting them to a design meeting during which we engaged in a conversation about their teaching. An outline emerged as the conversation was reconstructed to reflect *our* interpretation of what should be captured on videotape as representative of "best" teaching. However, once we authorized the exemplar's story of effective teaching with videotape, we realized that we would not be able to use some of those stories. Was then the exemplar still part of our mutual story of effective teaching? And, if we were free to reject particular footage, were we not then reconstructing the story *exclusively?*

Once consensus was reached, we developed a loose script to guide the production team on location. We were open with whatever knowledge we had as to the purpose and future use of the videotapes and completed videodisc, always aware of the implied personal and professional risks. Given our view of collaborative design, we also acknowledged the importance of mutually constructed meaning with the production crew who were effectively in charge of implementing design decisions. Although final editing decisions reflected our instructional plan, those decisions *had* to be based on the existing videotape sequences.

In the videotaping phase of the project we felt a moral obligation to minimize disruptions caused by the process--for us an issue of integrity. The negotiation of physical entry and exit at times brought us into conflict with the agenda of the production crew. Being classroom teachers ourselves, we were particularly sensitive to this issue, while the professional concerns of the production crew were to capture the best shots under the best sound and lighting conditions, most expeditiously and with the least amount of videotape.

Integrity

Noddings (1986) stated that "caring ... can provide steady rational guidance in the forms of questions to be asked and directions to be taken" (p. 506). Operating with an ethic of care encompassed two distinct responsibilities: guarding the personal/professional integrity of all participants and ensuring that the final product maintained the integrity of the research proposal. When these imperatives were at cross purposes, the question became how to maintain faithfulness to both. Integrity issues included intentionality, authenticity, and the dignity and privacy of the exemplars.

Intentionality

Intentionality refers both to the instructor's pedagogical purposes for various teaching decisions, and to what purpose the videotape record is put. The ethical question in this case was: Can a sequence be used conceptually in a way that was not necessarily intended by the exemplar? The potential for misinterpreted intentionality became particularly acute as we logged sequences from a second language class. Although we circumvented the danger by involving the instructor in the logging process, we became aware of the likelihood that we had misinterpreted sequences from other classes. The next time we undertook a similar project we would invite all the *exemplars* to log, or participate in logging, their own teaching sequences.

Authenticity

As the design story was mutually constructed and plurivocal, so must be the understanding of events recorded in the classroom. More than one truth exists in the recording of a single image: the images recorded on tape have already filtered through the understanding and experience of the videographer. Can film dramas ever constitute an authentic record of the culture, the complexities, of teaching? Some teaching sequences had to be staged. In those cases, is what is conveyed to the audience authentic?

The nature of videodisc technology itself frames the authenticity of recorded events. Rapid random access that is user-controlled segments what is presumed to be a holistic act. The very open-endedness of videodisc invites an idiosyncratic ordering or understanding of events unintended by the subject. Videodisc as the medium in which truth may reside emphasizes that "pictures do not simply make assertions, but rather (require us to) interact with them in order to arrive at conclusions--in short, that we play an active role in the process" (Becker, 1979, p. 106) of constructing meaning from recordings of classroom events. In addition, this open-endedness can be used to extend meaning, as we did by making use of the second audio track available to us. On two of the four sides of the videodiscs, the exemplars were invited to speak to their edited and ordered teaching sequences. This channel encouraged a deeper personal analysis for the teacher, in which sense it could be said to inform and even transform practice, but it could also alter the reality of the event. And on a third side of the disc, the teaching sequences were debriefed by Graham Fishburne from within our conceptual framework of effective teaching, with no reference to the understanding of the exemplars involved.

A third concern about authenticity relates to the presence of the television production crew in the classroom. Introducing the production element changes somewhat the nature of the interaction among students, the teacher, and observers on the scene. The stops and starts that characterize location shooting not only interrupt the flow of the lesson but actually provide the context for the teaching that is to take place. Being of the culture of the classroom ourselves we knew that capturing one moment in time was not representational of the complexity of the teaching act and may actually have disrupted the pedagogical purpose of the instructor.

Dignity and Privacy

Heider (1976) identifies privacy of participants as the central ethical consideration in videotape research. For us, maintaining the dignity of our exemplars was an explicit requirement of the collaborative design process, subsuming issues of power and voice. Privacy or anonymity was a separate issue, being impossible to guarantee or maintain because of the public and permanent nature of such a mass-produced and widely-distributed medium as videodisc. In addition, participation in such a project was of value in decisions about tenure and promotion, a public academic process. We reconciled the requirements of dignity and privacy by remaining faithful to the collaborative process described here. Trusting the collaborative process meant trusting that an *authentic* videodisc would be made.

Fidelity to the dignity of the teaching exemplars was exemplified by our commitment to the research aftermath of which Lawrence Lightfoot (1983) speaks. We had to consider whether our presence in the classroom had a fundamental impact on the culture either during the videotaping or after we had gone. For instance, did the choice of one classroom and instructor over another alter the students' perceptions of the effectiveness of their other instructors? Also implied in fidelity is the idea of fair return--inclusion on a videodisc showcasing exemplary teaching was fair enough return for the participating teachers, but what about the rest of the community, the students? Did the reflectivity required of their teachers translate into better practice, better teaching, for the benefit of the students?

Concern for the effect of strangers on a cultural community such as the university classroom, and the inevitable ongoing impact on life in that classroom, leads us to the final dilemma, or set of dilemmas, explored in this paper: dilemmas of power and authority and, ultimately, accountability.

Accountability

We alluded to expectations of accountability earlier in this paper. In this last section we want to explore our obligation to be accountable to the view of effective teaching that was expected by our sponsors, and how that expectation affected both the design and the production of the final videodiscs.

Is there a truth about effective teaching to be discovered? If so, then the teachers that we approached must exemplify this view; become moral authorities. Central to this view was the documentation of classroom teaching--documentation implied endorsement, but it also implied evaluation. For us, this was an issue of power and ideology. Essentially, the design proceeded according to our view of "good teaching", and although we designed by collaborative conversations with our exemplars, the fact remains that the exemplars we invited into the process were selected as sympathetic to this view. Since the design conversation required negotiation, we were comfortable in the end with our accommodation to a mutually constructed understanding of good teaching, and the technology itself, via the second audio track, also afforded an opportunity to present two versions of an event. But, whose account counts most in a project of this nature? And, what to do with volunteers, responding to our call for good teachers, that didn't fit our construction?

What's Next?

The project described in this paper, and the moral dilemmas it engendered, is not finished. Work continues on the development of print-based materials such as accompanying inservice manuals, and on hypercard stacks that will link, elaborate, and annotate the ideas explored on each of the four sides of the videodiscs. Nor has the personal impact of this process on each of its collaborative participants been lessened. Each of the authors/designers and teaching exemplars has been forced to some degree to examine their own teaching practice in the context of their new constructions of effective teaching. Living out new understandings of practice is ultimately a transformative experience and, after Tappan and Mikel-Brown (1991), a process of growth and moral development.

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[1] The University of Alberta's *Standards for the Protection of Human Research Participants*, 1991, is typical of these standards.

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Practical Classroom Uses of HyperCard

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MORE INFO
ON CD-ROM

One of the most useful and versatile programs for the Macintosh is also one of the oldest, HyperCard. HyperCard, an authoring tool, provides teachers with a practical tool to use in the classroom. A strength in using HyperCard is the ability to either start from scratch, or tap into the large number of public domain stacks.

Levels of HyperCard Activity

There are many HyperCard stacks in existence. Some stacks were made with a particular group in mind, while others were made for general purposes. These stacks may be modified, in most cases, to suit your needs, and if there are no stacks to match your goals you may also design your own. This paper will discuss examples on three levels of HyperCard use: (1) using existing stacks, (2) modifying existing stacks, and (3) creating your own stacks.

Equipment Needs

To use HyperCard successfully as a tool there are minimum equipment requirements which must be met to avoid major logistical problems.

1. Macintosh Lab - A Macintosh lab with networked stations is an ideal way to use HyperCard. A projection unit is useful for presentations. Access to a scanner or a digital camera adds the ability to import graphics into stacks.
2. Macintosh on a cart - Several rolling carts equipped with computers is an alternative to a lab. Depending upon the activity, the use of five computers is a workable situation in a class of thirty. Divide the class into groups. If there are fewer computers available, teachers can devise learning stations and divide the class into two or three activities. This allows groups to rotate through the various activities and computers.
3. A Macintosh and Magnabyte - If materials are limited or the topic lends itself to a class presentation, one Macintosh on a cart with an overhead projection unit or a TV monitor link works well.
4. Macintosh, Minicam and Monitor - If an overhead projection unit is not available, then use a minicam, shooting live. Hook the camera to a large screen monitor and the picture is often better than the magnabyte.

PUPPIES

Just as there are different student learning styles, there are a variety of methods available for using HyperCard to match those styles. A survey of commercial and teacher generated stacks shows that stacks can be divided into at least seven categories. Using the acronym PUPPIES, the stacks can be used to accomplish the following:

Presentations
Utilities
Problem Solving
Practice
Information Management
Extracting Data
Simulations

Practical Examples of Classroom Use

HyperCard allows faculty and students to create useful stacks without requiring complicated programming. This is a powerful tool but, as in all uses of technology, it is best to be sure the outcomes or objectives of the curriculum are presented and not just the technology.

The following examples of practical uses of HyperCard have been used and evaluated over a period of years. Sometimes the original form of the lesson did not work as well as expected so modifications were made as necessary. Using HyperCard allows these changes to be made easily, even while the lessons are being used.

With experience gained from inservice training, teachers can learn to use HyperCard in the classroom in a variety of ways. Provided below are examples of stacks that have been used in the classroom. Many of these stacks will be made available through the Teacher Education Internet Server.

Presentations

Stacks can be used to introduce a topic or act as a guide during a presentation. Presentations are appropriate for small or large groups depending upon the equipment available.

1. Practical Classroom Uses of HyperCard - a stack that presents an outline of this paper and allows the user to see examples of each of the stacks described.
2. Tutorials - there are many commercial HyperCard stacks to introduce and train people in the operation of their programs.
3. Tessellations - This program explains and gives examples of how tessellations are constructed. Tessellations are repeating patterns made famous by M.C.Escher. The stack contains tessellations made by a tenth grade general mathematics class.
4. Rocket Introduction - a motivation for a long term project of designing a space station. An animated rocket blasts off and leads into a description of the requirements for the project.
5. Seasonal Show - a stack created by tenth grade students that were linked together for a holiday presentation. This stack was made available to the administrators, the front office staff, and to individual classes.

Utilities

Stacks can be used in organizing the classroom or the teacher work environment and can serve as simple custom made utilities.

1. Seating Chart - a HyperCard Educator's stack used to make customized seating charts that may be tied to grades and other activities in the Educators' stacks.
2. Planner - a HyperCard Educator's stack consisting of a calendar and event planner that allows daily planning and features search procedures. This stack was changed to be used as Macintosh start-up program to show the present day calendar and events.
3. Quiz Maker - Quiz Maker is one of many stacks which may be found in The Waite Group's *Tricks of the HyperTalk Masters*. This book provides in depth examples of how to take full advantage of the HyperTalk programming language. All the stacks in this book are available on disk.
4. Ideas Stack - This is an idea storage stack with easily accessible information. This stack is good to have open while working on the computer when that special idea pops up and you need a place to write it.

Problem Solving

Stacks can be used to teach problem solving.

1. Related Rates - teaches the concept of related rates using animations and pop-up fields to organize an algorithm for solving related rates problems.
2. Ohm's Law - is used to check student problem solving abilities. Students solve Ohm's Law problems on paper, then enter their data and the answers into the stack. The stack then uses the data entered to calculate the answer and compare it to the student's.looking at the numeric answer and the units of measurement. There are help screens to show students possible places for error. The students then recalculate and and reenter the information until they are correct.

Practice

Stacks can be used to practice particular skills.

1. Angle Man - draws random angles and then asks the user to guess the angle within a selected range of accuracy. Angle Man has been used in a Macintosh lab on individual computers. This stack has been adapted for use by a teacher with a projection unit and used as a review before a science optic lab. Based upon techer reports, the students then performed the angle measurements for the lab with fewer problems than usual.
2. Jeopardy - Modeled after the television show, this stack was written to provide practice for the Maryland Functional Mathematics Test (MFMT). The categories for Jeopardy are the seven categories for the MFMT: Number Concepts, Whole Numbers, Decimals, Fractions, Mixed Numbers, Problem Solving, Using Data. The point amounts are 10, 20, 30, 40, and 50. Of course, there are two randomly selected daily double questions in each game. For each category and amount there are five questions which are randomly chosen in each game. That means there are one hundred thirty-five question cards. Each card has a script. To create the stack a button was made to put the script on each of the cards. That way instead of having to type the script for each card, just click on the button and, presto, the job is done. The stack took several months to create. However, it was well worth the time. The students love playing the game and competing against each other. And it helps them pass the MFMT, a graduation requirement!

Information Management

Stacks can be used to store and organize information.

1. Geometry Notebook - stacks made by students to satisfy teacher's course requirements. The students use HyperCard to record their notes. HyperCard is, among other things, a pictorial database.
2. Animal Cards - a student designed format to store information about animals for a biology project. The stack contains five cards per animal showing habitat,

geographical distribution, characteristics, classification information and a student generated graphic of the animal.

3. Laser Disc --Optical Data's biology laser disk and database uses a HyperCard stack to allow searches, image choices and editing lessons. This stack manages a gigantic database which keeps track of all the slides and movies on the laser disk and enables the computer to function as a remote control for the laser disk player. Faculty and students using the database can construct customized lessons using the powers of HyperCard and the images of Optical Data.
4. CD ROM - Many CD ROM disks are using HyperCard as the front end operating system.

Extracting Data

Interfacing with electronic data collection equipment can be accomplished with HyperCard stacks.

1. Universal Lab Interface (ULI)- Electronic equipment can be used to gather information from a remote site. The information can be stored on the ULI then dumped back into the Macintosh using a commercially made HyperCard stack. One teacher has designed a yeast carbon dioxide generator that has light sensors to count the number of bubbles produced as a function of time during fermentation. This experiment has been set up to collect data over the weekend and then the data is transferred back to the Macintosh through HyperCard.

Simulations

Stacks may be used to demonstrate concepts that may be too difficult or costly to construct.

1. Rube Goldberg - students are asked to design a mechanical system that will perform a simple task in a complicated way using HyperCard to show an animated sequence of the actions used to perform the task. The students choose four motions to analyze relative to the force causing the motion, the law that is best demonstrated, and the reason they chose that law. Buttons and fields are created so a viewer of the stack can see this information. Examples created thus far include a nail free contraptions that fed a cat while the owner is in bed, took out the garbage while the designer watched TV, and started a motorcycle with a bow and arrow.
2. Sonar - demonstrates how sonar works. Using an external command in the stack script allows a simulation of a ship traveling over an undulating ocean bottom. By clicking a button, the ships sends a sonar wave to the bottom and detects the echo. The depth of the bottom is then displayed on the HyperCard screen.

Conclusion

HyperCard should be looked at as a tool used to facilitate students reaching the outcomes of the course. As with any program, experience with HyperCard will allow the instructor to see more and more ways of using it. Once you have accumulated many stacks, you can even use HyperCard to organize them using a simple menu.

HyperCard is a single application that can serve a variety of functions. With the pressures of time already high, instructors can learn this one program and still have a multifaceted approach to their curriculum. The ease with which students pick up the basics of HyperCard also is a benefit in allowing them to produce individual or group projects that involve higher levels of thinking. HyperCard, along with other authoring programs, acts as a link between the curriculum and the power of technology.

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Empowering Teachers to Develop MultiMedia Software Applications

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The purpose of this presentation is to explain how teachers from public schools are working with faculty from the School of Education at the University of South Dakota (USD) to better meet their technology needs relative to multimedia production. The School of Education is participating with clusters of regional school districts in the development and operation of a Project called the Professional Development Center (PDC). This initiative includes providing assistance to first year teachers, professional development for practicing teachers, and technical and professional resources to local schools. The PDC is a cluster of regional classrooms focused on the applications of research and technology demonstrating the best teaching and learning practices for the benefit of school children, practicing educators, university education students and faculty, and the community.

This model utilizes a cost-effective approach to teacher, curriculum, and technology development. It consists of clusters of rural school district classrooms with mentor teachers modeling or demonstrating exemplary educational practices, curricula, and applications of research and technology to interns and to other members of the school district and community who are actively involved in the formal or informal delivery of education. This approach encourages the exchange of ideas, materials, teaching methodologies, software development and demonstration, and provides opportunities to influence both existing professional practices in school districts and teacher education program development at USD.

The PDC cluster provides a contractual financial arrangement in which the participating school districts and the School of Education share responsibilities to support year-long internships and mentorships to bring advanced degree expertise to bear on the improvement of education. This concept provides for the development of an induction program leading to Master's degrees for licensed first-year educators who are placed as interns and mentored by experienced teachers pursuing advanced degrees and university faculty placed on-site as demonstration teachers, advisors, and professional consultants.

One of the course requirements for the PDC mentors and interns is a course in applied multimedia technology for the classroom. The class consists of a set of modules which include instructional modules and computer-assisted tutorials which are designed to be self-paced. The premise for developing the course in this manner was that motivated teachers want to know the material they need to learn, want the time to work on it and do exploration, and want some type of organized response.

The teachers from each school form a "team" which is assigned an individual logon for identification, a password, and disk space on the network server. Group folders on the server are password protected and help the teams keep their materials organized. Since storage space is a major concern with multimedia projects, adequate storage space is designated for each team.

The class has been designed so it is project oriented, where the teachers first learn about authoring skills and then practice those skills to develop a multimedia project which is relevant to their school and/or community. The general theme or their assigned project focuses on the role of education in economic development in their individual communities, and their task is to develop a multimedia production using the designated software. The teachers are also encouraged to involve the students at their schools to help with designing the project parameters and to assist with the videotaping and photographing duties.

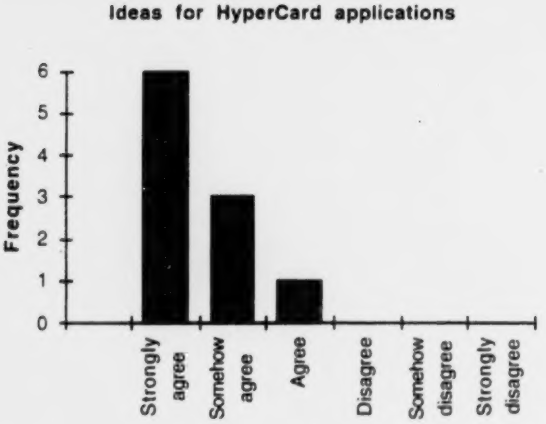
Ideas for HyperCard applications

Figure 1.

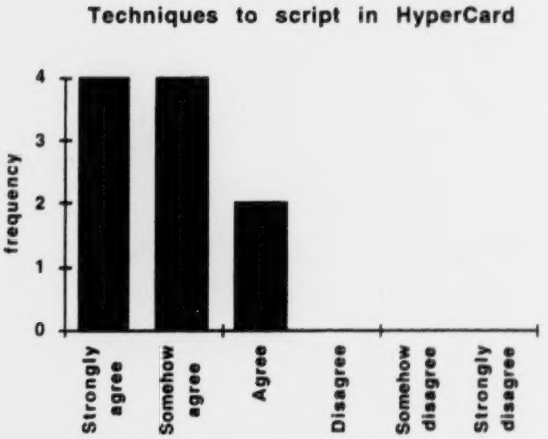
Techniques to script in HyperCard

Figure 2.

Application programs covered in the course include the following: Adobe Premiere, Screenplay, Morph, Adobe Photoshop, Hyperstudio, Macromedia Director, Ofoto, Sound Edit Pro, and Aldus Persuasion. For most of the programs, tutorials in the traditional form of booklets have been created to introduce the teachers to the software packages. The teachers are required to work through the tutorials and successfully complete an assignment before moving on to more advanced concepts and skills. Two of the programs also have on-line tutorials utilizing the NotePad program. The teacher teams work at each of the stations for three class periods. Because the class is devoted to the application of technology, a paperless reflection form has been created using FastForms for the teachers to use when submitting their individual reactions to each of the lessons.

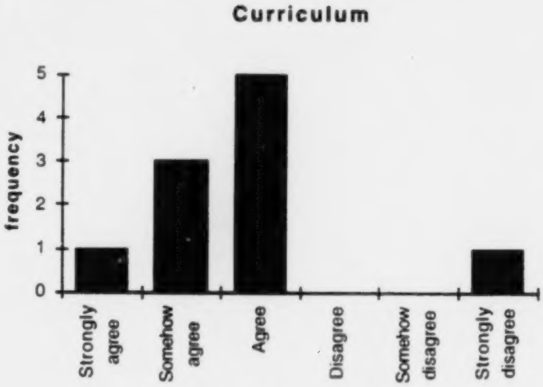
Curriculum

Figure 3.

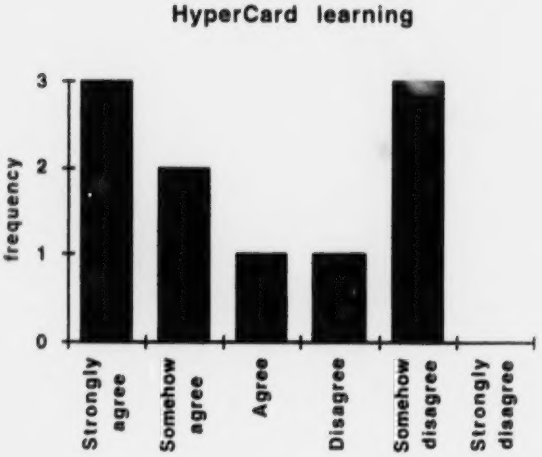
HyperCard learning

Figure 4.

This is the second year of the PDC program and the multimedia class has been offered three times in a variety of formats. Some of the reactions and observation of those classes are as follows:

- Use of modules required self-directed members of the teams in order to be successful in the time frame of one semester.
- Due to deadline constraints on completing the final project, the teams require a greater amount of time and access to the equipment in the computer lab.
- Use of the server is invaluable, not only because of the size of the files created, but also because of the myriad of small problems that arise. Server access to the team files by the instructors also allowed assistance at times other than classtime.

- The on-line tutorials were well-intended but not well-used, especially when printed materials were available.
- The paperless form program used for reflection became more popular as the team members became familiar with the process of recording their thoughts on the word processor immediately after they had experienced one of the programs.
- Teams of teachers working on projects like these can strain physical resources. The ability to distribute work over the network helped, but it can also complicate the process as well.

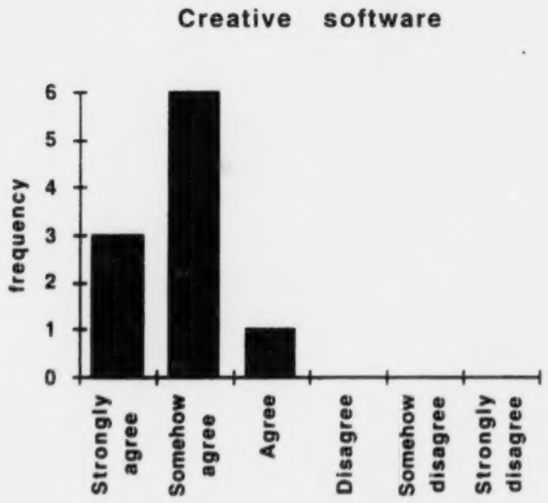

Figure 5.

In summary, the quality of the finished projects has varied widely from school to school. High-tech tools do not replace the vision of what one wants to accomplish, wither in the design of a project or as a final goal of the project. As with many projects, the lack of vision should not be construed as a lack of ability with available technology. Teachers who are already pushing the limits of their abilities and visions are perhaps the best candidates for technology instruction about multimedia in this format. This class has provided the medium for university faculty, public school teachers and students, and people from the community to work together to develop a product of mutual interest, which in itself is significant. Despite some limitation resources, the class has proven to be very popular and it will continue to evolve as more teachers provide input into its design and applicability for the improvement of instruction and learning.

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Teachers as Authors: HyperCard Projects for the Classroom: A Case Study

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"National standards will leave our children in the dark without the true integration of technology" is the thesis of the cover story article written by Therese Mageau and Linda Chion-Kenney in the October issue of Electronic Learning (1994). In the same article, industry consultant Peter Kelman is quoted as saying, "Technology is being slighted by most of the national standards groups, and when they've included it, it is usually lip service." He adds, "National standards groups and the educators who will be implementing the standards need to understand in a profound way that the 21st century in which our children will be lifelong learners and workers is one in which comfort with and command over technology is a prerequisite for survival."

David Steiner (1994), assistant professor of political science at Vanderbilt University, and a member of one of the civics national standards committee, feels that the new standards "are celebrating a Victorian separation between the academic disciplines." He adds, "Today our hardware and software possibilities make a nonsense of divisions among disciplines." In contrast, "Imagine what could be achieved if we could come to a consensus on a number of integrated curricula, each developed with the best computer and communications programs available."

One way our schools of education can help is by empowering teachers in the use of technology. When teachers are exposed to the best hardware and software available and they are taught how to integrate the technology into the curriculum, they can become agents of change.

The value of "teaching programming" has been debated by many researchers. One type of programming that seems to offer new and exciting possibilities is programming using authoring languages such as HyperTalk for HyperCard and Open Script for Toolbook. Teachers can be curriculum developers and software developers by working with authoring environments like these. With this premise in mind I incorporated HyperTalk and/or Open Script authoring in Masters-level courses in Technology and Learning. The study I will describe was prompted by the results I accomplished teaching HyperCard using a project-oriented approach.

This study was undertaken to study teachers' perceptions of the learning, use, curriculum integration, and ease-of-learning of textbook versus project-oriented teaching of HyperTalk. The ten Orange County teachers in the study taught at either the elementary or high school level -the projects they developed addressed different areas of the curriculum. I personally observed these teachers for the length of the course and interviewed them at the end. A questionnaire was also given to all of them. An account of the observations, interviews with the teachers, and the responses to the questionnaire are given in the study.

In this study, ten teachers enrolled in a masters course in HyperTalk scripting used HyperCard on the Macintosh to create multimedia projects for use in their classrooms. The course was taught using a project-oriented approach. The book chosen to teach the course, *The HyperCard Projects Book* (Balzano, 1994), consisted of twelve projects of increasing difficulty in Hypertalk scripting. After completing the first six projects in the book the students were grouped to create their own projects.

Purpose

This study explored teachers' perceptions of the learning, use, curriculum integration, and ease-of-learning of textbook versus project-oriented teaching of HyperTalk.

Did the course in HyperTalk scripting give ideas to teachers for HyperCard applications? Have teachers learned useful techniques to script in HyperCard language? Did teachers think of HyperCard when there was a need for something to be done in their curriculum?

Some specific questions on advantages of disadvantages of textbook versus project-oriented instruction were explored in reference to learning HyperTalk.

In addition the HyperCard projects created by the teachers were analyzed to see how well they have integrated the scripting concepts learned during the course. Did the projects in *The HyperCard Projects Book* prove useful to the teachers? Had the teachers incorporated specific scripting used in the book? Did the projects incorporate interactivity?

Project Description

Ten teachers enrolled in a ten week masters course in HyperTalk scripting participated in this project during the Spring of 1994. The course, taught by me, met once a week for four hours. These ten teachers had taken an introductory course in HyperCard during the previous quarter; this course was also taught by me. A textbook on HyperCard (Harris, 1993) was used during the Winter quarter. The teachers were assigned readings and exercises from the book. At the end of the course they created their own projects.

The HyperCard Projects Book used during the Spring quarter contained twelve projects. The projects included in the book were designed and selected according to some specific criteria adopted by the author. The projects had been tried out with a variety of audiences, from third grade children to practicing teachers. The author included projects that a) different people had found interesting, b) allowed people's individuality show through, c) people could see a purpose in, d) had important key ideas related to the scripting, e) were fun to make and, f) exhibited some kind of sequence.

During the first five weeks of the course the teachers individually completed the first five projects. A sixth project was randomly assigned to each one of the teachers. All the projects were presented and discussed by the teachers and I. The Macintosh lab was equipped with eight Performa 400's and two Quadra 610's, a flatbed graphics scanner, a videodisc player, and printers. During the last five weeks of the course the teachers worked in groups of three or four to develop their final projects.

Methodology

This study was an exploratory multiple case study (Yin, 1993). Four sources of data were explored: my observations, four teacher interviews, a written questionnaire and analysis of project stacks.

My observations

During each session I observed the teachers for part of their hands-on activities. The observations focused on students' ease of completing the projects in the book, and their interactions with the other teachers.

Teacher interviews

I interviewed one randomly selected teacher from each of the groups to get a better understanding of the use of a project-oriented approach versus a textbook approach in learning HyperTalk scripting.

Written questionnaire

The questionnaire consisted of five six-point Likert-scale questions and four open-ended questions.

Analysis of students' stacks

Students' final group projects were analyzed in terms of (a) level of scripting, (b) curriculum content, (c) design, (d) interactivity. Did the students incorporate a level of scripting comparable to that used in their textbook? Did the projects cover a defined area of their class curriculum? How well was the information organized? Did the projects communicate the information clearly and effectively? Did the projects allow for interactivity?

Findings

The findings are organized around the main questions that guided the study. These involve teachers' perceptions of the learning, use, curriculum integration, and ease of learning of textbook versus project-oriented teaching of HyperTalk.

For each of the following questions the teachers were asked to say if they strongly agree, somehow agree, agree, somehow disagree, or strongly disagree.

Reflecting on your experience of learning HyperCard during the Spring Quarter of 94 how would you respond to the following?

A. I feel I can come out with ideas for HyperCard Applications.

There was a strong agreement on this question. Six out of ten teachers strongly agreed that they could come out with ideas for HyperCard applications. (see Figure 1)

B. I have learned a number of useful techniques to script in HyperCard language.

The agreement on this question was divided between strongly agreeing, somehow agreeing and agreeing. (see Figure 2)

C. When I see a need for curriculum I think of a way of doing it with HyperCard.

Only one teacher strongly agreed on this question while one strongly disagreed. Half of the teachers agree. (see Figure 4)

D. HyperCard was more difficult to learn that I thought it would be.

Teachers were split on this question with six agreeing and four disagreeing.

E. I would call HyperCard a creative software medium.

All ten teachers agreed that to varying degrees, HyperCard is a creative software medium..(see Figure 5)

Learning from a textbook and learning from projects both have advantages and disadvantages. List two advantages of learning from a textbook.

Here are some of the answers:

- Textbooks are a great reference and source of information. Reading a textbook is an individual learning experience, where projects often involve input from an outside source, i.e. peers, teachers, co-operative group.
- A clear advantage of textbooks is that they provide a great resource that can be easily accessible to all students. The material is usually presented logically, covers the subject thoroughly, and follows an outline form. Because textbooks follow an outline form, they can be used to teach students to summarize. Also, it is easy to keep a class together during the discussion; everyone can be on the same page, looking at the same material.
- Learning from a textbook and learning from projects both have advantages and disadvantages. List two disadvantages of learning from a textbook.

Some of the answers to this questions were:

- A textbook tends to build on its own information, therefore it needs to be read in order, from the beginning to the end. That tends to limit its flexibility.
- Reading a book can be very lonely, especially when the material is dry or difficult to understand.
- Computers are changing so fast that the information is outdated by the time the book is published.
- Learning from a textbook and learning from projects both have advantages and disadvantages. List two advantages of learning from projects.

Some responses to this question were:

- Hands-on experience are a wonderful way to experience learning. It makes learning more meaningful and it's a lot more fun.
- Projects are adaptable to students needs and abilities; they create something that the student can use.
- When students work on a project, they become much more the organizer, they must think out, and plan the project. They will be much more familiar with the material learned, as they work with this material, and incorporate it into a project. Secondly, students will be proud of the work they did to complete a project. They have ownership invested in it. As they share their project with others, they will take the role of teacher. Of course, to teach something you must truly understand the material and concepts.
- Projects can seemingly be more creative, varied and the diversity makes it enjoyable. Projects seem more personable and more easily manipulated to meet our needs.
- Learning from a textbook and learning from projects both have advantages and disadvantages. List two disadvantages of learning from projects.

Some of the answers to this question were:

- A person must be self-motivated because the required materials often take more time to create and gather. Projects require a higher level of thinking.
- May be too difficult to do without having first studied a textbook.
- Less structure. Time gets away from students. Possibly miss skills that particular projects might not include.
- A disadvantage I see in projects is sometimes their focus is too small. The student might complete the project without ever getting a feel for the larger concepts and themes of the material being covered in the class. A second disadvantage might be that if a student is not very structured, a project can seem overwhelming. Sometimes it gets away from the student. There is a point where the student realizes that there is no way the project can be completed on time, therefore the student gives up, and accomplishes nothing.

To further clarify the usefulness of the projects' book used in the class I interviewed four of the teachers. In conducting these interviews I was interested in getting a sense of how confident the teachers felt about using HyperCard. There are definite differences between using a textbook with readings and exercises and a textbook containing projects. It is possible to go through a book without completing the readings or the exercises and still have a good idea of the book's content; projects need to be completed to know if they work or not. The demands on the student with a project-oriented book are higher than that on a textbook with readings and exercises. Would this make a difference in the level of confidence of the teachers in using HyperCard? One of the teachers felt that not only the projects had been very useful for his group project, but they also provided a good resource of ideas for his practicum project. Another teacher indicated that the projects really got her to think and they were very useful in helping her group design different parts of their project. A chemistry teacher said she now felt confident to design a stack to use in her classroom.

Please comment on the usefulness of the projects included in The HyperCard Projects Book.

Three of the teachers responded that the projects were useful and one teacher felt they were not useful to her because she only had IBM computers at her school.

Please comment on how much the projects in The HyperCard Projects Book helped you in designing your group project.

The four teachers responded that the projects included in the book were very useful in designing their group project.

HyperCard Projects

One of the HyperCard projects was created by four elementary teachers, and it contained four different stacks. Sue, a first-grade teacher designed a story on penguins; the stack incorporated animation and scanned images. Marianne developed a stack to be used as part of a unit on oceans; students in her class had to guess the depth of the ocean.

This stack adapted ideas learned in the course, and it was highly interactive. Susan used a videodisc on clouds and used her stack to access relevant frames. Kristin developed a stack on the water cycle; the stack was interactive and had animation in many of the cards.

A group consisting of a fifth grade teacher, a chemistry teacher, and a person with a computer business chose to make an all-purpose teaching stack that could be used by students nine years and older. The project was called The Morning Routine; these teachers used many of the new programming ideas learned in Balzano's book (1994).

Another group of elementary teachers adapted a Richard Scarry's story on bears; the story shows the bear waking up, getting dressed, and having breakfast. The pictures included in the stack were scanned from the book, and they also incorporated many programming ideas learned during the course.

A group of high-school teachers created a stack on the human body; this group captured video to create QuickTime movies, scanned graphics from textbooks and used animation for some of their cards.

It was satisfying to see how well these teachers were able to adapt ideas learned during the course into their projects. The degree of interactivity and the sophistication of the scripting seemed to indicate a strong understanding of the scripting learned in The HyperCard Projects Book.

Conclusions

The ten teachers involved in this project developed confidence in HyperCard authoring and created hypermedia group projects involving text, scanned graphics, sound, and videodiscs. Both the teachers and I felt the time spent in creating the projects was well worth the effort.

The teachers felt that the advantages in using a project approach in learning HyperTalk scripting outweigh the disadvantages. One aspect of a project approach emphasized by the teachers was its usefulness in adapting their learning to their personal needs. When looking at the disadvantages of a project approach they all agree that it requires more discipline and motivation. The basic advantage of using a textbook was the thorough coverage of the subject matter while a disadvantage was the irrelevance of some of the materials covered in a book.

The technology to support multimedia and hypermedia is becoming more widely available in schools. Multimedia technologies have great potential to empower learners' development of higher-order thinking skills (Dede, 1992). Marchionini (1988) contended that hypermedia has the potential to alter the roles of teacher and learner and the interactions between them. Worldwide, a small but growing number of teachers are creating their own instructional multimedia lessons combining audio, video, animation, text, and graphics (Sponder & Hilgenfeld, 1994). Teachers will be able to do a better job in using these technologies in their classes if they feel confident about using them. This exploratory study shows teachers creating HyperCard projects relevant to the curriculum taught in their classes. These teachers, exposed to the best hardware and software available, and taught how to integrate the technology into the curriculum, have taken the first steps toward becoming agents of change.

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HyperCard for Children: A Case Study and Suggestions for Teachers

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Hypermedia has been a part of the advancement of computer technology for quite sometime. One of the most common and still state-of-the-art products is HyperCard for Macintosh computers. However, it seems that educators have failed to reach a level of mastery of HyperCard when compared to other tools. In fact, since the debut of HyperCard a number of other products have come and gone and still more have evolved beyond their initial format.

In the world of hypermedia technology, cost can be prohibitive as Wulfekuhle (1994) describes, "Besides all of the necessary hardware, the authoring software itself is likely to cost up to $5000." (p. 77). While teachers are not generally involved in major programming of computer-based training, they can utilize hypermedia themselves as well as providing hypermedia to students for use with traditional material. Although not new on the hypermedia scene, HyperCard for Macintosh computers still seems a relatively powerful and easy to use tool which can be easily adapted to a great many educational objectives from helping teachers manage their responsibilities to serving in the instructional/learning process itself.

Wilson (1994) quotes a variety of individuals who address the development and expansion of hypermedia. James Lichtenberg (vice-president of the higher-education division of the Association of American Publishers) is quoted as saying that such technology is still limited to the original interested professors and has not yet been adapted to classroom teaching. Mr. Lichtenberg warns that this will soon change.

Sammons's (1994) concerns that teachers are reluctant to adopt and integrate such computing tools (multimedia) into their work is equally applicable to HyperCard. She cites such things as "lack of equipment, ..time, and ..knowledge about a number of topics." (p. 89). While Mr. Lichtenberg seems optimistic about the future, Sammons suggests some specific conditions for integration of such tools including the seemingly omnipresent prerequisite: it must be easy to use.

However, very little is known about how students use and can learn from and with a large variety of computer technologies – especially Hypercard. While Macintosh computers have a reputation of being "user-friendly" and point-and-click software usually seems to be some of the easiest available today, how easy is HyperCard to use? While HyperCard is still a powerful tool and seems relatively easy to use, more should be learned about its use in a variety of contexts and, if teachers are to use HyperCard in hands-on lessons, then for children in particular.

The Study

A group of 18 middle school students, members of an inner-city academically gifted and talented program, participated in a 4 week summer course at a midwestern state university. The students could not be randomly selected for this study and were available only because they enrolled in the summer workshop program. The group included both males and females and everyone had very little, if any, prior computer experience and virtually no experience using HyperCard or other hyper-media software.

The course began with two weeks of general orientation to Macintosh computers and minor projects with miscellaneous graphics and drawing software. The last two weeks students focused exclusively on using HyperCard to develop a presentation project (called a "stack") of their own design.

Each stack was to include some sort of action sequence appearing as an automated changing screen display ("cards"), although the particular design and mixture of graphics and text was left to the student. Students were free to create multiple cards (screens) to present information or images linked in any order or sequence as they desired.

Important Questions

It is important to learn more about how middle school–aged children use a software product like HyperCard. For example, how are card views designed? That is, are graphics emphasized over text and which graphic design tools are relied on? How do students design card linkages? That is, how are buttons ("hotspots" for mouse clicking) used, what effects are created, and what kind of path through the cards (Linear, Multidirectional) is allowed? Etc. What artistic skill is drawing screen images might students be capable of? That is, are straight lines really straight? Are drawing tools used creatively and effectively? What overall quality of card appearance can such students achieve? Certainly, HyperCard provides one of the easiest user–interfaces and simplest tool sets available today. But, maybe a more advanced level of artistic skill must be developed before acceptable views can be created.

Of equal concern is the process itself. What difficulties do students experience? That is, do students get lost in the stack, loose track of cards, encounter developmental errors? After all, while HyperCard employs a metaphor implying that one is simply drawing on a series of cards in stack, it is still very much a kind of programming language – regardless of how automated or easy to operate. So, since students are actually in the process of programming, what confusing situations or problem solving strategies are encountered in the process. This latter question, certainly fundamental to effective usage and learning issues, would be better addressed after first exploring some of the earlier questions discussed above.

The Nature of the Inquiry

While the classification of Gifted or Talented is of less importance and less interest in this study, these students provided an opportunity to explore some of the important questions as described above. In this spirit, observations and data collection were somewhat open–ended and designed to focus on a variety of the basic concerns. Each student was consulted and individually observed privately at least once in the process of developing their report. Discussions and observations focused on what they were creating, what their intentions and goals for completion were and what kind of problems they were having.

At the end of the course each student completed a survey which addressed the tools used (eg. scanner), text and graphics used and the nature of the animation techniques (changing images, movement, etc.). The survey also addressed students' affective impressions about their experiences using HyperCard. The final element of data collection included the stack itself.

The class was taught by two instructors, a college professor of educational computing and a high school computer lab manager. HyperCard was demonstrated on large screen projection and students were guided through a series of exercises before setting out on their own project. The technical range of material in the course included only minor "scripting" (manually programming the underlying code of a stack rather than relying exclusively on automated features) for the sake of simple card–flip animation.

Results & Discussion

Generally, students' screen views were primitive in appearance and poorly developed. Views were mainly drawn with a single tool (the pen or line tool) regardless of the nature of the image (Figure 1). For example, human figures were generally drawn as stick figures. Likewise, other kinds of characters, objects, landscape features and more were drawn equally simplistic rather than what might have been achieved by mixing the graphics using a variety of tools. Of course while a particular screen image may seem simplistic, the card–flip animation did provide significant enhancement to the overall presentation in spite of most all cards in the sequence being similar in complexity.

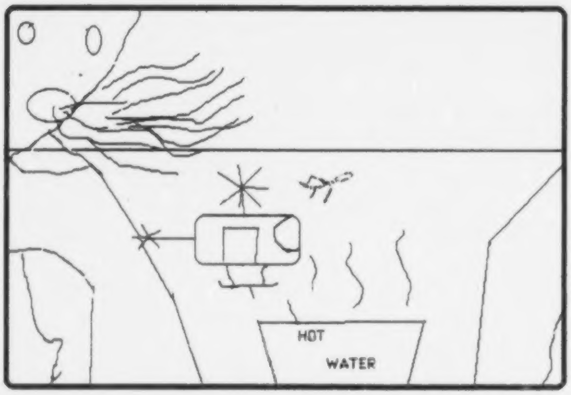

Figure 1. Example of drawings with over reliance on a single tool.

For the most part, students relied on one or two drawing tools even in situations where alternatives would have served better. In other situations students seemed to want to include the use (effect) of certain tools regardless of whether or not it actually improved the screen view. This was most evident in cases of the fill tool which tended to clutter the screen with patterns which conflicted with text or other items displayed (Figure 2.) The fill tool had similarly undesirable effects on drawn objects. Note in figure 2 how awkward use of the fill tool can leave open–space letters (O,D,P,B,Q, etc.) unfilled. One useful effect provided by a fill tool is to make text appear to be superimposed upon a constant background surface. This typically requires two things: (a) open–space letters must be filled in, and (b) the particular background pattern should be complimentary to and consistent with the font style of the text placed upon it. Notice in figure 2 how both of these attributes are compromised.

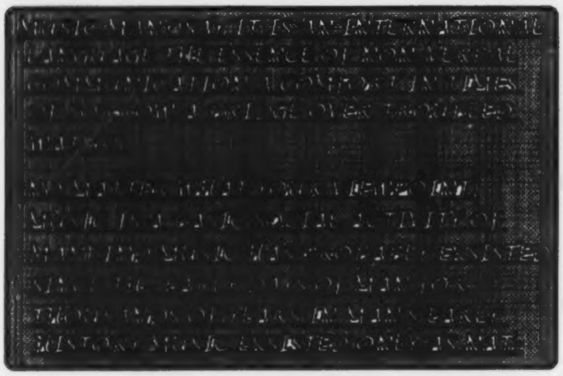

Figure 2. Example of drawings damaged by poor use of FILL tool.

Not all images were poor, one–dimensional or involved single tools. There were a couple of cases where drawings were relatively more sophisticated (Figures 3 and 4). However, students' control over such detail was generally the exception rather than the rule. Such students' presentation stacks were generally consistently similar in quality (other drawings and animated sequences) to the quality of even a single screen image.

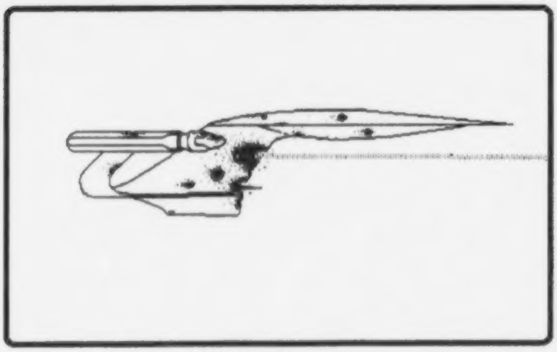

Figure 3. Example of sophisticated and higher-quality drawing #1.

While all the drawings were somewhat primitive and simplistic, the ideas for animation which students attempted were reasonably interesting and ambitious. Action sequences included a box falling down a stair case, the Star Trek space ship "Enterprise" exploding, a fish dipping in and out of water, a race car and driver crashing, and more. Seeing their creations in motion on the screen provided considerable enjoyment and feelings of accomplishment.

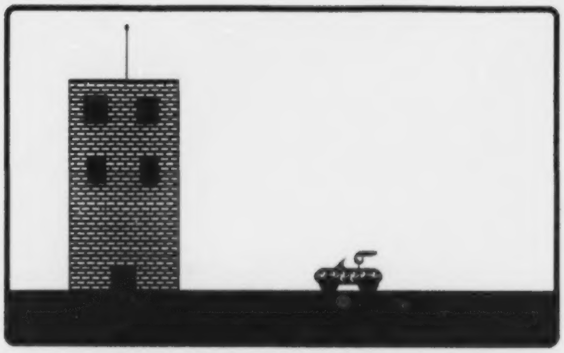

Figure 4. Example of sophisticated and higher-quality drawing #2.

However, most animation sequences were plagued with structural functional errors. Often, students had created buttons to control the animation but which were not actually linked to anything. They were dormant and entirely without effect. Also, throughout the stacks there were blank cards with no content and without purpose. Likewise, there were frequently early versions of other cards which had been duplicated but remained undeveloped and unaltered. Cards were often created without any buttons and were therefore not linked to anything and thus allowed no ingress or egress short of manually manipulating the stack with arrow keys (which students had been told to specifically avoid).

There were a variety of drawing subtleties which could have improved students' screen images. For example, when a new button is installed, the name NEW BUTTON actually appears on the object. Students tended to allow this to remain in its original form rather than modifying the object's style and appearance to conform to some overall theme or plan. Also, where imperfections occurred in a relatively high–quality image, students either did not notice, did not object or did not know how to fix or fine–tune such details in their drawing. For example, filling the screen with a pattern after placing large text on the screen typically results in the open letters (D, O, Q, B, P, etc.) not being filled in (Figure 2). Often, simply clicking in the open letter with the fill tool corrects the problem. Typically, students ignored this phenomenon and other such subtleties.

Regarding the nature of card branching (linear vs. multidirectional: see Figure 5), the project itself did not generally call for nor did the students seek to create multidirectional linkages between cards. The task of creating simple animation and the time available precluded the development of a multidirectional presentation.

In spite of the preceding evaluation of their final products being somewhat negative, students generally reported that the experience was considerably enjoyable and that the software was generally easy to use. Students' primary difficulty had to do with navigating their way through their stack. They frequently lost track of which card was which, whether they were working on the first card of the stack (the first card provides the opening scene when

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the stack is initially opened.), or on a newly created card, etc. When created, new cards appear totally void of links to other cards and it can easily appear as if one's prior images have simply disappeared leaving one with no embedded functions with which to navigate the stack. More importantly, students had not learned to mark cards in some distinctive way in order to more easily identify and differentiate them. Likewise, students were generally more concerned with how to draw with the graphics tools (realizing that a degree of artistic skill would be helpful) than with tracking the development of the overall stack.

It seems that instruction on the application and function of individual drawing tools may be insufficient to expect students of this age to integrate them and develop their use with imagination and creativity on their own. Specific practice on combining the effects of the various tools is suggested.

There are a variety of techniques which can assist students in keeping track of cards but certainly instruction must specifically emphasize the importance of such awareness. While it is technically unnecessary, cards can and should be specifically named. Students have to be encouraged to check and continually monitor the names of cards being edited in order to keep track of which is which.

There are naturally occurring difficulties with regards to card order. For example, viewing and then deleting card number 5 of a 10 card stack causes card number 6 to become the 5th in the series, the 7th to become the 6th and so on. The student is not notified of this adjustment when deleting card number 5. They must understand that deleting card number 5 does not leave a kind of hole in the series – there is simply 9 total cards in stead of the original 10.

Another example is copying a card. Using the clipboard to first copy an existing card and then paste it immediately into the stack of course creates two cards exactly alike. Pasting inserts the card copy (card #2) directly behind the first (card #1). However, since the cards are duplicates and no confirmation is given by the computer, it can easily appear as if no change occurred. Consequently, students may paste several copies of the card in futile attempts to see a change thus creating a second, third, fourth, version of the original. Then, to make matters worse, backtracking through the cards with arrow keys also appears to have no affect since they are identical.

Another significant difficulty which invariably reoccurred was how to substitute a different card for the first one in the stack. That is, once students were more deeply involved they then had different ideas about how the opening view of the stack should appear. So, they wished to substitute a new card for the first card of the stack thus changing the opening view. Since pasting necessarily inserts cards after an existing card there is no way to position oneself prior to the first card as would be needed. The required technique is more involved and virtually every student with this goal needed one–on–one assistance.

It is suggested that students first preplan their presentations on index cards or even blank sheets of paper. Certainly, it may be worthwhile to provide an exercise for students in manipulating index cards to help show how card sequence can be affected. Teachers can direct the activity to simulate the experience of creating, deleting and even linking screen views (cards) using the index cards as concrete manipulatives.

Many areas for future research remain. Of particular interest is an exploration into what subject areas and topics HyperMedia might best be used in. What differences would color or other development features – which are beginning to appear in some of the newer versions of various HyperMedia – make in the effectiveness or usefulness of the final product? How do on–screen drawing tools (and input devices like a mouse) compare with more traditional paper/pencil/crayon/chalk drawings?

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Odyssey of Developing Creativity with Computers: Speeding Train or Brick Wall?

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Speeding train or brick wall? Facilitator or barrier? What is the role of the computer in early childhood education? This continues to be the great debate.

According to Beckelman, 1993,

> "The computer's essence is plastic in the truest sense of the word. It is more malleable than finger-paints, less ephemeral, yet changeable as a piano chord. It offers a unique combination of impermanence and replicability, encouraging that basis of all artistic basics: messing around" (p. 107).

It is this unique feature of both the computer and art experiences that make this combination an attractive means by which to foster the development of creativity in young children.

Rationale

A recent United States Department of Labor report (1992) states that students will need certain skills to thrive in the twenty-first Century: coping with change, working cooperatively, taking responsibility, and solving problems. The development of creative thinking and flexibility through the use of computers provides the foundation for the development of these skills (Clements, 1991). It is no longer adequate to equip children with "the facts"; rather, we must seek to prepare the child to live in a world of many cultures which may have no use for the facts they have learned.

Art spans cultures creating a pathway to a universal language. With the advent of the information highway, the computer becomes a transparent tool in which cultures communicate with one another. The future beams bright for those individuals who know "how to learn" and use their knowledge and tools of their society in participation and communication with persons from cultures distinctly different from their own, both at home and in the world at large. Computers and their related technologies are not intended to replace conventional tools but rather to join the ranks of those objects at the disposal of each individual such as paper, pencils, various art media, manipulatives, or books (Clements, 1985; Fite, 1993; Papert, 1992). Providing computers as educational resources readily available and used appropriately within meaningful contexts offers a solution with clear goals: (a) avoiding the mechanistic nature of simply knowing how to operate and control an object, and (b) providing a scaffold for the development of a unique individual who is gaining a growing and creative knowledge of the intrinsic self, the extrinsic world and the special relationships between the two.

Historical Background

In *The Third Wave* (Toffler, 1980), the author refers to the overload of data and imagery heaped upon the current generation who are ill prepared to critically analyze or use such information. This perspective illuminates the past obsession with the acquisition of facts without regard to the development of creative thinking and children's interaction with technology. With the exception of LOGO, software in the Eighties was largely drill-and-practice causing great debate among early childhood educators on the appropriate-

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ness of using computers with young children (Woodhill, 1987). Some advocates of technology argue that computers are now a part of our culture to which children should be exposed (Ziajka, 1983). On the other hand, many early childhood educators are strongly opposed to the use of such advanced forms of technology (Barnes & Hill, 1983; Cuffaro, 1984).

Linear
Multidirectional

Figure 5. Linear vs. Multi-directional card linkages and presentation sequence.

Currently, open-ended programs, multimedia, and advancements in LOGO provide a developmentally appropriate foundation exemplifying the constructivist philosophy (Clements, Nastasi, & Swaminathan, 1993). With the adoption of this philosophy coupled with the discovery-oriented world of the computer, children can be empowered to tap into their creative potential (Clements, 1986; Papert, 1980). "When the computer is used appropriately, it has the potential to involve children more than television does, it is less static than picture books, and as open-ended as crayons"(p.10, Shade & Watson, 1988).

Within the arena of this great debate, the area of developing creativity through the arts has been exceedingly neglected in terms of computer integration. Historically, integrating the use of art and the computer is not seen as a necessary or meaningful activity in most schools (Kearsley, Hunter, & Furlong, 1992). Disregarding the fact that the computer is used by all forms of art professionals in the "real world" the computer continues to be used as a support for the more "serious" academic endeavors such as math and science.

Currently, some research efforts support the contention that the computer environment when coupled with the process of creating through art can lead to enhancement of both cognition and creativity (Clements, 1991; Escobedo & Bhargava, 1990). This new perspective added to a recent addendum to the revised Goals 2000 now listed under the Improving America's Schools Act (1994) listing the arts as "challenging subject matter" that all students are required to master, will continue to highlight the unique and important contributions art as well as the computer environment has to offer our children.

Art making, appreciating, analyzing, and critiquing, is the road to the truly educated individual. In an article devoted to the Arts in Education, Oddleifson (1994) states,

> "...arts related intelligences are the source of concepts, and concepts are essential for the construction of meaning. Since the arts represent organized forms of perception, we conclude that higher levels of abstract thought—i.e., critical and creative thinking capabilities-are dependent to a significant extent on artistic thinking" (p. 448).

All forms of art should be offered as an integral, transparent, integrated tool to all students on a consistent basis. Through this provision the facilitation of the development of creativity is provided.

Creativity can be defined as being constructed of four components: (a) the process, (b) the product, (c) the person, and (d) the creative situation (MacKinnon, 1965). Additionally, creativity has been viewed as an aspect of intelligence (Guilford, 1977) involving the process of finding missing elements, forming new ideas around them, testing out the new concepts and providing modification (Torrance, 1962). Such as process cannot be taught, yet environments can be structured in such a manner in which creativity becomes a self-discovered invention of combining old concepts into new patterns of thinking. It is the elements of invention through self-discovery offered by the arts and the computer environment in which students can become actively involved developing creative thinking.

Methodology

Statement of the Problem

The technology advancements of recent years provides new tools easily utilized by young children. Art is now recognized as one of the critical national goals and for its contribution to higher level thinking. The time has come to explore the value of computer art in contrast to general art as strategies to enhance creativity.

Purpose

The purpose of this ethnographic inquiry was to identify patterns in the development of creativity in two groups of young children as evidenced through language process and art products as they are engaged in (a) general art , and (b) computer art activities. In both types of activities two types of stimuli were used: free exploration and structured art stimulus. The dependent variables are the four criteria of creativity: fluency, flexibility, elaboration, and originality.

Sample Characteristics

The sample was randomly selected from intact kindergarten classrooms in two different school communities. Upon return of parental permission forms, ten children in each school setting were randomly assigned to the research group. Group I consisted of children from affluent families; children in Group II were from Headstart families.

Group I included: (a) 3 males, 7 females, (b) 6 White, 3 African American, 1 Other, (c) nine 5-year-olds, one 6-year-old, (d) English primary language, and (e) 2 below average SES, 2 average SES, and 6 above average SES.

Group II included (a) 5 males, 5 females, (b) 2 White, 5 African American, 3 Hispanic, (c) eight 5-year-olds, two 6-year-olds, (d) English primary language for 7 and 3 Spanish primary language, and (e) 9 below average SES, 1 average SES.

Research Questions

(1) What are the patterns of differences or similarities in language process expressed during general and computer art activities for and between Groups I and II, in relation to creativity dimensions: fluency, flexibility, elaboration, and originality.

(2) How do general products compare to computer products for and between Groups I and II, in relation to the creativity dimensions.

(3) How do general products compare to computer products for and between Groups I and II (1) free exploration, and (2) structural change in relation to the creativity dimensions?

Instrumentation

Rating scales were developed for both language process and art products. Development of these scales was a collaborative process between the principal investigator and a licensed Educational Diagnostician. Interrater reliabilities based on 10% of the data were established: language process evaluations—94.8%; computer product evaluations—92.75%; and general art product evaluations—91.45%

Implementation

This study was conducted over a six week period. The first two weeks were spent obtaining the necessary approval for completion of the study, volunteering in the two classrooms, and collecting both school and student demographic data. The last four weeks were spent observing and collecting data. The schedule was as follows: (a) week one—general art activities at school A; (b) week two—computer supported art activities at school A; (c) week three—general art activities at school B; and (d) week four—computer supported art activities at school B. At the end of this period the data were analyzed according to the previously described procedures.

Data Collection

Both schools utilized Macintosh LCs and KidPix drawing software. General art activities included manila paper and various markers, crayons, and colored pencils. Data were collected by videotaping and observation. Each student pair were video-taped in four 20-minute art sessions, two of which were traditional in nature and two computer supported. During each of these four sessions the pairs of students produced two products based on: (1) free exploration, and (2) changing a previously drawn shape into another object. The researcher scripted the procedures of the students as they were engaged in the art activities.

Data Analysis

Video-taped language during each type of activity was transcribed and analyzed for patterns of differences and similarities within the criteria of originality, flexibility, fluency, and elaboration. The language process indicators for these criteria were: (a) expression of a unique idea (originality), (b) number of changes in language within a category (flexibility), (c) number of different topics discussed (fluency), and (d) adding to an idea or extending a category (elaboration).

The product indicators included:(a) creation of a unique idea (originality), (b) variety or number of different ideas or categories (flexibility), (c) number of different objects created (fluency), and (d) adding to an idea or extending a category (elaboration).

An evaluation scale was developed for both the evaluation of language process and art products. Each criterion was scaled at two weights: slight =1 or significant differences=2. Thus, significant performance resulted in increased reported frequencies. For example, "slight" in language process might be unrelated language; "slight" in art products might be a token mark or scribble without identified meaning.

General patterns of topics which emerged from the language were: (a) directive language, (b) explaining, (c) exclaiming, and (d) questioning and answering. Language transcriptions were coded according to these patterns. Then each transcription was examined on the designated indicators for the four creativity criteria. These were then scored, and plotted on a matrix to examine the differences and similarities between the two groups and the general population involvement in the two types of computer supported art and two types of general art activities. In both research settings the kindergartners experienced (a) exploring freely, and (b) changing a previously drawn shape into another object.

The same procedure was then followed in examining the art products. Field notes of scripted procedures taken of each student during the art activities were coordinated with both product and process analysis for effective evaluation.

Findings

The questions examined patterns in each group under language process and art products as well as these patterns for the entire group. The patterns are contrasted on: fluency, flexibility, elaboration, and originality. This summary addresses: (a) Group I from the advantaged community, (b) Group II from the disadvantaged community, (c) comparison of the two groups, and (d) comparisons of free vs. structured art activities for both groups.

Group I: Analysis of the language process resulted in higher frequencies of performance resulting from the computer experiences for each creativity criterion: fluency, flexibility, elaboration, and originality. The art products of this same group of advantaged kindergartners were assessed with higher fluency and flexibility resulting from general art, but higher elaboration in the computer activity. Originality was not measurably different from the two experiences.

Group II: Analysis of the language process resulted in higher frequencies of performance resulting from the computer experiences for each creativity criterion: fluency, flexibility, elaboration, and originality. The assessment of the art products of this disadvantaged group paralleled that of Group I demonstrating higher fluency and flexibility resulting from general art, but higher elaboration resulting from the computer activity.

Group I and Group II: The profiles of the affluent and disadvantaged group were quite dissimilar in the language process. Group I experiencing either general art or computer activity performed at significantly higher levels on flexibility than did Group II subjects. Group II subjects experiencing either general art or computer activity performed at significantly higher levels on elaboration.

Alternative Art Stimuli: Across both groups, comparisons were made on the creativity criteria contrasting the free art activities to the structured art stimulus. Both groups performed at higher frequency levels on fluency than on the other factors. However, of particular interest, is the higher performance for both groups from the free art activities of either type, general art or computer.

Limitations

The sample size limits the study to descriptive statistics, but provides important insights for further exploration. The data collection was limited in time span, but videotaped for exhaustive transcription and coding. The researcher's field notes clarified the activities for analysis purposes, but the presence of the researcher may have stimulated or limited the expressive language of the students or their art activities.

Rating scales for four dimensions of creativity were developed to assess the language process and also the art products. There is no standardized test for this assessment, and interater reliabilities were established for each dimension at levels of .91 to .95.

This study provided art and computer activities to both groups. There was no control group to control for maturation or enriching school activities.

Implications

This study addresses the great debate on utilization of computers with young children. In particular, it contrasts the impact of general art activities and computer art activities on four creativity criteria: fluency, flexibility, elaboration, and originality. Since the sample included kindergartners from two types of communities, the study suggests differences in these consequences related to demographic factors. The study supports both art and computer technology as means to support development of creativity. Further, it suggests that a free and open environment in either case is most supportive of creativity. The rating instruments directed to creativity dimensions are promising for expanded studies. Research designed for larger samples, standardized tests, and longer treatment times could establish a contemporary answer to the great debate.

Technological tools such as computers, and interactive video are as much a part of our current society as the earlier, simpler forms of technology such as books (Haugland, 1994; McMillan, 1988; Shade, 1993; Sheingold, 1984). In order for education to provide the type of environment that resembles a world learning laboratory in which children come to learn how to be part of the global world in which we live, it is necessary to give them all the tools of that world for direct engagement. In addition, as we move into the twenty-first century, the combination of the intelligences of the arts (Gardner, 1993) and computer interaction becomes an obvious and necessary advancement. It is the unique features of both the computer environment and art experiences that make this combination an attraction addition to the early childhood classroom. The question of limitations or enhancement of the development of creativity in young children through computer supported art activities is a question worthy of continued study.

One answer to the debate over whether or not to expose children to technology lies in the manner in which it is carried out (Clements, 1985; Fite 1993; Haughland, 1994). Building from a foundation of a humanistic and constructivist attitudes toward technology and its impact on the educational life of a young child, teachers and students can board the speeding technology train with a vision of early childhood education designed to enhance the development of creativity and prepare our children for positive real-world participation.

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The Design/ Implementation of a Multi-Media Teaching Tool for Preservice Teacher Education

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Transitions occurring in teacher education programs within higher education direct the need to prepare preservice teachers for restructured elementary and middle school classrooms for today and tomorrow. Designing authentic learning environments for preservice teachers becomes a challenging and rewarding task for university faculty members. As the authors began their challenge of planning for an authentic learning environment, they addressed the *guiding question of:* How do we better prepare preservice teachers for future classrooms based on Goals 2000 and state and national standards? This question provided the focus for initially designing and planning a collaboration project between the authors that led to the development of a multi-media program. The program facilitates preservice teachers' experience in developing a thematic unit based on an integrated curriculum. The specific content areas addressed are children's and adolescents' literature, mathematics, and language arts. It is the intent of this paper to review our instructional design problems within the specific content areas, discuss the initial collaboration project which led to the development of the multi-media project, and then provide illustrations from the multi-media project.

Instructional Design Problems

The mandates of national standards and the Kentucky Educational Reform Act of 1990 set the stage for identifying instructional design problems. Specifically, legislation of the Kentucky Educational Reform Act of 1990 (KERA) stipulates that new teachers design learning environments that include the: (a) integration of skills, higher-order thinking processes and content across disciplines, (b) design of activities for multiple levels of difficulty in order to adapt instruction for students at various levels, (c) development of learners' ability to apply knowledge, skills, and thinking processes, (d) application of multiple teaching and learning strategies that are appropriate based on students' developmental levels, (e) engagement of students through questioning to stimulate higher order thinking, and (f) incorporation of creative and appropriate uses of technology. These new teacher standards provided the focus for identifying a major instructional problem, and then identifying more precise problems related to content areas and their integration.

A main problem identified was how to include the integration of higher-order thinking processes and content across disciplines and to incorporate the appropriate use of technology. More precise problems which were common to the three content areas included how to: (a) develop an integrated curriculum as opposed to designing lessons for specific skills taught in isolated areas, (b) develop yearly, monthly, and daily lessons relating to real-life situations (viz., authentic tasks), (c) use national and state standards as well as state curriculum guides to facilitate the process of designing and planning for instruction and assessment, (d) use trade books with traditional textbooks for designing thematic units, and (e) provide an environment where preservice teachers become coaches and facilitators of learning rather than disseminators of information. A precise problem identified for the content area of children's and adolescents' literature included how to use a variety of genres in literature (e.g., biography, information books, realistic fiction, poetry) and instructional materials. The focal problem identified within the mathematics content area was how to promote concept development through a problem solving format. In language arts, the problem was getting students to view the teacher's role as that of helping children to enrich and expand their oral and written language, and to use language for learning, thinking, communicating and problem solving.

Initial Collaboration Project

The university professors agreed to engage in an collaborated effort so that preservice teachers could participate in designing, planning, implementing, and managing instruction based on components of KERA and Kentucky New Teacher Standards. Contact was initiated with a public school to collaborate with teachers and students within elementary and middle school settings. A piece of literature, *The Phantom Tollbooth*, by Norton Juster, was identified and used to anchor the integration of mathematics and language arts. University class assignments were made for each of the three courses taught by the authors. For children's and adolescents' literature, students composed a book annotation, compiled an index of quotations for *The Phantom Tollbooth*, and generated a bibliography of related books and poems. The language arts students wrote, illustrated and bound a related predictable book for use with primary students as they developed reading strategies. Mathematics methods students identified mathematics concepts discussed in the book. Activities, games, and lessons were designed to teach the concepts which were correlated with the National Council of Teachers of Mathematics and Kentucky mathematics standards.

The culminating activity for the preservice teachers was to design, plan, and produce activities and materials for a learning fair. This learning fair took place in the public school setting so that preservice teachers could evaluate such elements as their: (a) adaption of the materials and activities based on students' abilities, and developmental level; and (b) teaching and learning strategies which actively engaged the learners. Students in grades K-6 visited the learning fair during a three-day period, using the learning center activities under the direction of university students. The learning fair was videotaped, allowing for scenarios to be constructed by the university professors for an interactive multi-media teaching tool.

Development of the Multi-media Project

It is important for faculty to model for their students the use of technology. It is also important for students to have experience with multi-media. A requirement of KERA is for teachers to make use of various forms of emerging technologies within the classroom. If newly certified teachers are to meet this requirement, university faculty need to give their students an opportunity to utilize an interactive multi-media environment in order to gain familiarity with the technology. Therefore the next state of collaboration was to summarize and organize The Phantom Tollbooth Learning Fair experience in a multi-media format so that it could be used with subsequent university classes.

Developing such multi-media products requires time, instructional design abilities, content expertise, and technology expertise. While the professors were all competent in their fields, presenting the content in an interactive multimedia product was a new experience. Using an instructional design approach, discussion and research were used to expand their knowledge base and design the product. The level of technology expertise among the professors increased as each professor learned or enhanced technological skills needed to develop the product.

The first step in the project following the learning fair was for the professors to create a videotape based on footage taped during the fair. A script was written and recorded for each segment selected. The professors developed learning sequences which included descriptions of the content and/or pedagogy involved with a particular video clip. For each sequence, discussion questions were developed so that preservice teachers could think critically about what had been presented. To address the main problem of using technology to integrate higher-order thinking processes and content across disciplines, the professors worked with an instructional designer to put the information and tasks into an interactive multi-media learning format for use by preservice teachers.

Figure 1 shows the overall format of the multi-media program. This format acted as an organizer for both the development of the program and for students as they interacted with it.

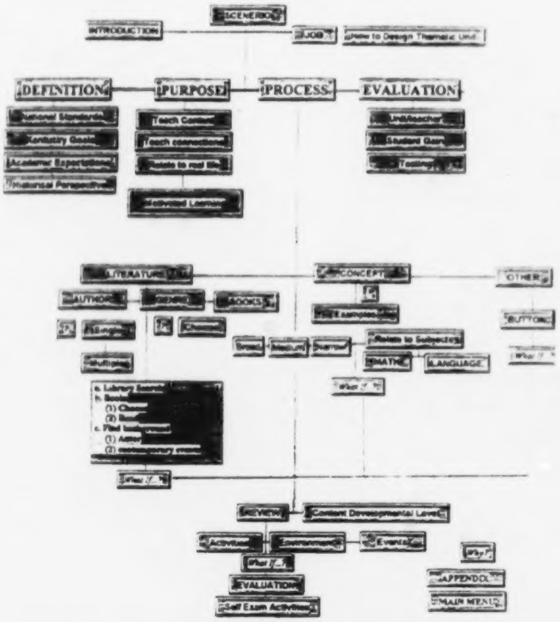

Figure 1. Illustration of the Program Format

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Illustrations from the Multi-media Project

The professors organized general information about thematic units and entered it into the introduction of the multi-media program. Students using the program were asked to read and react to a fictional scenario which represented a situation commonly faced by teachers in elementary/middle schools. They were given a task which involved collaborating with other teachers to design a broad thematic study for their students. To help them with this task, examples from The Phantom Tollbooth Learning Fair were included in the computer program, and a second book was identified to use in the simulated situation of designing their own activities.

The precise problems which were common to the three content areas were addressed with this format as well. Students were involved in planning and integrating curriculum with both short and long range plans. The task was an authentic one which required focusing on national and state standards, and was based on the use of trade books. Students were given practice in designing activities for a child-centered environment in which teachers function as facilitators of learning.

The precise problem related to children's and adolescents' literature was addressed by including in the multi-media program examples of genres found in literature. The Phantom Tollbooth was presented as an example of fantasy, and a list of books related to The Phantom Tollbooth was provided which included a variety of other genres. For example, *The Librarian Who Measured the Earth* by Kathryn Lasky, a biography, was presented as a related book focusing on the mathematics of measurement. *The Dot and the Line* by Norton Juster, an example of folklore, was presented as a related book focusing on word play and geometric shapes.

The precise problem for mathematics content was addressed by an example in the multi-media program involving the concept of numbers. A section of The Phantom Tollbooth in which the main character, Milo, was visiting the Mathemagician was given as an example of the meaning of large numbers. Preservice teachers engaged in a task of designing an activity where children were able to look at the concept of infinity. Using Milo's task of finding the greatest and smallest numbers, children were led to realize that each problem solution became a new problem.

To address the precise problem identified for language arts, the multi-media program provided examples of learning center activities in which children communicated with one another in oral and print modes. For example, one activity from The Phantom Tollbooth Learning Fair involved children giving and following directions in order to create "Monster Pictures" on a small chalkboard. This activity was related to the section of The Phantom Tollbooth where Milo was pursued by demons as he climbed to the Castle in the Air to rescue the princesses, Rhyme and Reason. Examples of using language in a holistic way were provided in a learning fair scene showing children reading books which had been written, illustrated, and bound by preservice teachers. The children then wrote their own books. This holistic use of language occurred in a "Castle" setting, and represented the restoration of Rhyme and Reason to their rightful position in the Kingdoms of Dictionopolis and Digitopolis. Children and preservice teachers were thus led to the idea that integrated/holistic curriculum is more reasonable than focusing on isolated skills and content areas.

Summary

The multi-media product allowed students to interact with authentic situations prior to teaching in a classroom setting. Students were introduced to the interactive product as a group. An assignment was then made for students to use the product in a computer lab. Following interaction with the multi-media product, preservice teachers were presented with a different piece of literature and asked to design and plan instruction for the integration of mathematics and language arts based on various teaching and learning strategies.

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Use of Videodisc Technology in Early Childhood Education: Implications for Teacher Training

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Technology has become an essential part of teacher training. Teacher educators face the challenge of how to best prepare tomorrow's teachers today to deal with the vast amount of information available in today's society and the rapid advancement in the information technology.

In recent years, we have seen many nationwide efforts in restructuring teacher education programs so that prospective teachers will be better prepared for the ever-changing society, in which technology will play a more prominent role in what and how they learn. General computer uses such as word processing, database, spreadsheet and programming/authoring are a part of most teacher training programs. Increasingly, various emerging technologies such as interactive multimedia and telecommunications have been incorporated into the teacher education curriculum. As educators begin to implement technologies in the classrooms and examine the role of technology in teacher education, more educators realize that merely teaching prospective teachers how to use these tools is insufficient. Johnson (1993) noted that "despite the tremendous potential of classroom implementation of learning technology, it also seems clear that mere availability of computers or images on a videodisc or videotape are not powerful in and of themselves " (p.29). Collis (1994) discussed various historical reasons for the lack of the integration of technology into the curriculum and called for shifting away from isolated computer uses to computer applications that are closely integrated with content areas such as mathematics, science, and language. The real value of the technology lies in teachers' creative uses of technology in the content areas.

This paper provides an example of how the interactive videodisc technology can be incorporated in early childhood education through presenting a HyperCard-based program using the videodisc *The Jungle Book*. This program was developed by an inservice teacher and was used to teach children the concepts of spatial relationships. In the paper, the issue of the developmental appropriateness of the videodisc technology for kindergarten age children is discussed. The result of a field-test of the program is presented.

The Interactive Videodisc Technology

One of the most recent technological advances in computers is the interactive multimedia technology. The potentials of this technology allow the development of systems that provide experiences in multiple contexts, encourage sharing of information among learners, and make available tools so that learners can construct personal knowledge structures (Nelson, 1994). As a form of the multimedia technology, the interactive videodisc technology offers new possibilities to create child-centered learning environments. Research findings related to the effects of interactive video have been positive (Hannafin & Colamaio, 1987).

There are three generally accepted labels for the levels of interactivity. A level III interactive videodisc system consists of a videodisc player controlled by a computer. The power and flexibility of the computer allow greater learner control and enhance interaction between the learner and the system. With such a system, a learner can determine which video segment to view, for how long and for how many times, and how to proceed from one point to another. "Repurposing" available videodiscs are increasingly common as authoring programs such as HyperCard have made the process easy and enjoyable. Repurposing is an authoring procedure used to change the original purpose of a videodisc. Individual frames or video sequences may be selected and ordered in a way to create an entirely new application (Phillipo, 1988). This capability allows one videodisc to be utilized for different purposes and audiences. The potentials of the videodisc technology with its nonlinear and interactive capabilities are yet to be fully explored.

Computer Use in Early Childhood Education

The role of computers in early childhood education is of critical importance as we prepare our children to develop the skills that will be necessary to be productive citizens and capable of entering the work force in the 21st century. Although some teachers of young children feel that the introduction of technology to the lower grades, kindergarten, and pre kindergarten will hamper the developmental appropriateness of their curriculum since computers are more abstract and only two dimensional, it was found in a questionnaire study that 91% of the parents polled and 80% of the teachers polled thought computers were appropriate for 3-5 year olds (Guddemi & Fite, 1991).

Computers are becoming more prevalent in early childhood programs. More than 25% of licensed preschools had computers as early as 1984 (Clements & Nastasi, 1993). The ratio of students to computers has decreased from 1:125 in 1984 to 1:22 in 1990 (Clements & Nastasi, 1993). Computers have been reported to aid in the development of language, motor skills, social-emotional growth and cognitive growth (Haugland & Shade, 1988; Wright, Shade, Thouvenelee, & Davidson, 1989).

Language Development

The computer graphics programs can be used to enhance language development and encourage verbal expression as children create and often narrate what appears on the screen. Young children have successfully used computers for word processing in emerging literacy programs (Guddemi & Fite, 1991). Emerging literate children are capable of seeing words printed on paper with printers empowering them to create letters and words independently (Wright et al., 1989). Children who write more with computers, as their skills advance, are likely to take increased pride and confidence in their writing. They have fewer fine motor control problems, and are more willing to take risks and revise, and build a sense of competence. Furthermore, the visual and auditory capabilities can be used to motivate children and allow nonreaders to use the computer more autonomously.

Motor Skill Development

The use of keyboards calls for precision and careful hand motions. This increases awareness of cause and effect so as not to hit more than one key or hold one down for too long. Controlling a mouse or a joystick adds a degree of precision. Literature has suggested that fine motor skills can be heightened through the use of a keyboard, mouse, joystick or touch window (Wright et al., 1989). Gross motor skills are exhibited in such programs as Panda Workout: How to Weigh an Elephant. This program encourages large muscle development as children design an exercise program with pictures and then exercise along with the music included. Not only are they exercising body parts but learning the names as well (Wright et al., 1989).

Social-Emotional and Cognitive Developments

Computers are seen to be tools to increase children's self-esteem and attitudes through working in a group on a computer program, solving a math problem together, or writing using a word-processor. Because computer skills are perceived to be valuable in schools and workplace, knowing how to use computers often make children feel good about themselves. Along with social-emotional development, the early childhood curriculum fosters cognitive development which can be assisted with the use of computers. Cognitive growth is much broader than acquiring skills such as counting, identifying shapes and colors, and matching and sorting objects. It includes exploring objects and materials to understand their properties, seeing the predictability of cause and effect relationship, and identifying consequences.

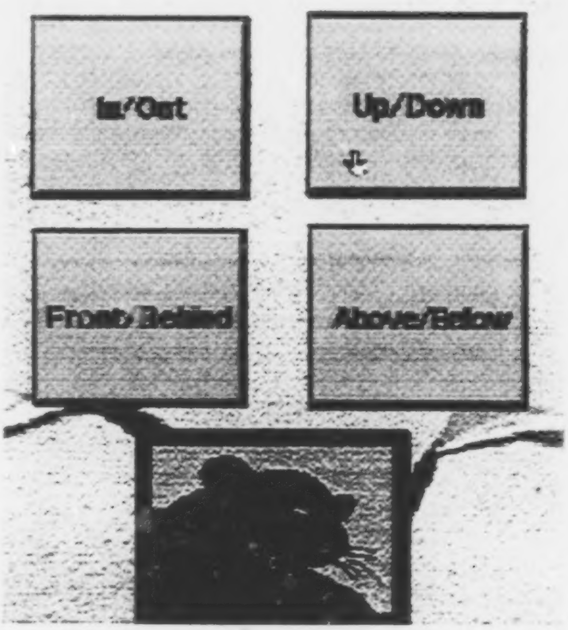
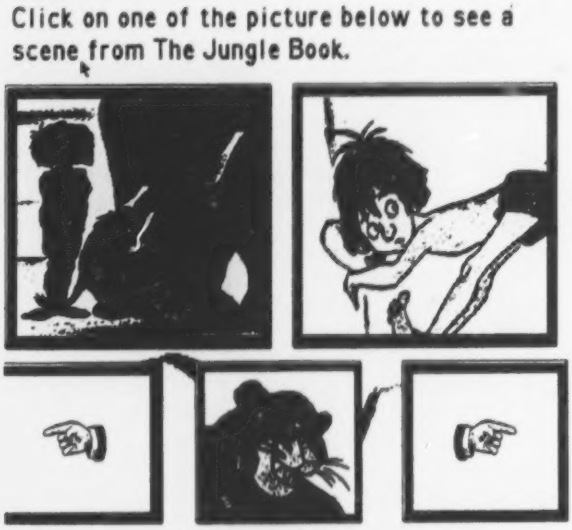


Figure 1. Main Menu

Papert's microworlds have been shown effective in assisting the cognitive development for children as young as three years old (Haugland & Shade, 1988). Symbolic representation is another important aspect of cognition in early childhood, because it is a part of one's ability to know his or her world, the ability to create symbols that allow humans to become familiar with their environment and to communicate their knowledge (Escobedo & Bhargava, 1991). Studies have shown that computer-generated graphics can assist young children in developing symbolic representations (Escobedo & Bhargava, 1991).

Computers clearly have potential to support children in all stages of development. To ensure that computers will have a positive impact on children, it is vital that children have easy access to the computers, and appropriate software are selected for the targeted age groups. More importantly, necessary training must be provided to the teachers so that they will be able to incorporate technology into their own teaching practice.



Click on one of the picture below to see a scene from The Jungle Book.

Figure 2. Illustrating the Concepts of Up and Down Using the Video Clips from The Jungle Book.

Using Interactive Videodisc Technology with Kindergarten Children: An Example

Computers are becoming more accessible to the schools. Because of the increase in curriculum topics on videodiscs and the decrease in hardware prices, many schools now own at least one videodisc player. The number of videodisc players in schools has increased from 1700 in 1985-86 year to 43,000 in 1987-88 school year (Helsel, 1988) and is continually growing. Literature has shown that videodisc technology has been used with adults, high school students and elementary school students. Little use of such technology is found in early childhood education. Is such technology developmentally appropriate for younger children? Can young children handle this technology?

In an attempt to address these issues, a HyperCard-based program was developed using the videodisc *The Jungle Book* to teach the concepts of spatial relationships to the kindergarten age children. The spatial relationship is a topic addressed in the curriculum for this age level. Using the videodisc, four paired topics (up/down, in/out, front/behind, and above/below) are presented through one of the children's favorite stories The Jungle Book.

Various media such as text, graphics, audio, and video are used in the program. When a child opens the program, a main menu with four pictures representing the four pairs of concepts and a picture of Bagheera will appear (see Figure 1). Bagheera is a black talking panther, a main character in the story. When the child clicks on Bagheera, the direction of how to proceed will be given orally. The child can then select the picture that represents any pair of the concepts to begin the activities.

There are two video clips from *The Jungle Book* story to illustrate each concept. For example, if the child selects the "up/down" concept, she can view the video clips illustrating this concept as many time as she would like (see Figure 2). A practice activity follows this viewing of the video clips to see if the child understands the concept. The child proceeds to the practice activity by clicking on an icon of a hand pointing to the right. A screen will appear with one scanned picture from the storybook itself, showing the "up" movement and another picture showing the "down" movement (see Figure 3). If the picture showing the direction "up" is selected, the word "up" will flash above the picture and a voice will say "Up!, here the elephant's trunk is up." Text and audio are used here to reinforce the concept.

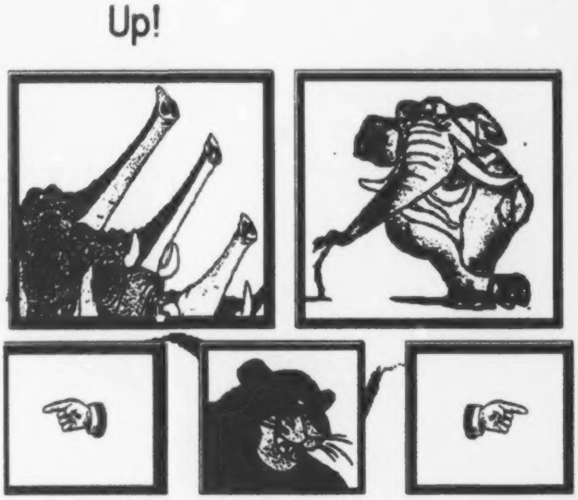


Figure 3. The Practice Activity for Up and Down.

Because the target audience is five-year old children, text is used minimally in the program. The spatial relationship concepts are presented through video and color graphics, rather than the text. Directions and feedback are given orally. Music from the story is used as a motivation device in the beginning of the program. The character Bagheera is available on all screens to give directions orally so that a child can identify him as a help button. The hot spots (buttons) on the screens are purposely designed to be big so that the young children, with limited motor skill development, can easily locate and select them. Children can concentrate on learning the spatial relationships by interacting with the computer at their own pace and through their own control. This program was designed to teach children the concepts of spatial relationships in a fun and motivating way.

To find out how kindergarten children feel about this program, this program was pilot-tested by three five year old children. Two of the three children were Hispanic, one male and one female. Another child was male Vietnamese. All three children were enrolled in a summer remediation program geared at enhancing their basic skills knowledge in English before entering the first grade. Based upon the test scores used at the kindergarten level, these children were classified to be of high ability (the Hispanic male child), medium ability (the Vietnamese male child) and low ability (the Hispanic female child). All three children had used computers with a mouse before this pilot test; however, none had used a videodisc player or a computer controlling the videodisc player. They were given the same instruction of how to use the program and they were told that clicking on Bagheera would give them directions for each screen. Observations were made of the three children during their use of the program. Each child tried out and completed all four activities individually. The children were given the opportunity to ask questions during the use of the program if needed.

After their use of the program, the children were asked six attitudinal questions. The questions addressed whether they enjoyed the program, whether the instruction was clear and the program was easy to use, and if they would participate in another interactive video learning activity. All three children said they enjoyed using the program and viewing the related video clips from the story. They said the directions were clear and the program was easy to use. The two boys said that they learned concepts "in front of", . "below", and "above" from the program while the girl said she did not learn anything from the program. All three children said they would like to participate in a different interactive videodisc learning activity in the future.

Based upon the observations, it was clear that the three children enjoyed seeing the graphics, the movement in the video and the sound. At times, the children would smile, laugh, and the boys would tap their feet to the beat of the music. It was also clear that these children did not have difficulty in clicking the appropriate buttons using a mouse to listen to the directions and/or feedback, and watch the video. The two boys asked similar questions in the beginning of the program as to whether they had selected the appropriate buttons. But they quickly gained independence and operated independently throughout the rest of the program. The girl appeared to have more problems in understanding the explanations in English. The directions had to be restated several times for her. However, she was able to complete the program.

Implications for Preservice and Inservice Teachers

Children of today are a generation that grow up with television, video games and computers. Computers are a part of their life. Unlike many adults, these children have little computer anxiety and are more accustomed to explore and discover when they are placed in front of the computers. It is obvious from this pilot test that the three children can use the videodisc technology without difficulty. If the program was in the native languages of these three children, we would anticipate fewer questions about the selection of the appropriate buttons. The multimedia aspect of the program proves to be an important factor to motivate children of this age. The fact that the concepts are taught in the context of a children's story and are illustrated through video clips appeared to be helpful in assisting the children to acquire the spatial relationship concepts.

To enhance children's learning through these types of programs, teachers themselves must be competent with the technology and capable of selecting the appropriate software for the children.

Just as a teacher is trained to use manipulatives in mathematics or to perform experiments in science, teachers must also be trained in computer applications, particularly in how to integrate computer technology into the curriculum. If teachers begin to see that these computer applications support teaching in their own content areas, they are more likely to use these applications for a more meaningful purpose.

The videodisc technology has become a technology that is readily available to the teachers at affordable prices. Many videodisc publishing companies produce a large number of educational videodiscs. Increasingly we see more and more textbooks published with accompanying videodiscs and barcodes. Companies such as Pioneer have demonstrated their commitment to the use of videodiscs in education. Teachers should take advantage of this technology. Although the videodisc players are available in many schools, they are not used to their full potential because many teachers lack the knowledge of how to use them effectively. To prepare students of tomorrow and help a generation which is ready for this new technology, teachers must be trained in how to best integrate technology into the curriculum.

The easy use of many authoring languages such as HyperCard makes it possible for teachers to develop programs in their own content areas using the existing materials. The example demonstrated in this paper was developed by an inservice teacher. The same videodisc The Jungle Book can be repurposed to teach topics as action verbs, adjectives, techniques of animation, mood as reflected by the music, essential and common knowledge such as why people yawn and so on. If teachers see a purpose in creating curriculum related materials, they are more likely to have a desire to be trained and motivated to use these tools effectively. As teachers become aware of their ability to make their own programs and they have access to the variety of videodiscs, the development of rich curriculum resources to enhance learning is only limited by their imaginations. It is at this point the technology will have fulfilled its maximum educational value.

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Selecting Appropriate Hypermedia Authoring Packages for Courseware Development

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As the graphics and sound capabilities of desktop and portable computers increases, so does the sophistication of the software used to develop hypermedia courseware. While there are many packages available to teachers for courseware development, most require time and expertise beyond that of the typical classroom teacher. Furthermore, as introductory educational technology courses for teachers become more daunting with additional topics, time spent on study of the use of hypermedia packages is limited. Yet hypermedia production should be a central component of a teacher's exposure to microcomputer use in the classroom in order to develop the capability of producing interesting, interactive lessons on the computer, and so that one's students may produce their own lessons by using a hypermedia package. This paper suggests criteria for selecting appropriate hypermedia authoring packages for use in a teacher education program.

What Makes an Appropriate Package?

What makes an "appropriate" hypermedia authoring package? In addition to its ease-of-use (both by the author and the user), certainly its use of the hypermedia/multimedia capabilities of the computer is crucial. These capabilities include: sound, video (animation and movies), hypertext, and full color capabilities. From among many, two packages which fulfill these criteria are HyperStudio, by Roger Wagner Publishing, Inc., and MediaLink, by InterEd, Inc. and the University of South Carolina. While there are many strengths in each of these packages, each has its unique features which permit it to be used for a variety of different purposes. The following presents an overview of each package with their salient features.

HyperStudio 2.0

HyperStudio was originally created for the Apple IIgs platform; a new version now for the Macintosh incorporates many of the original features with additional capabilities, including sophisticated tools for creating interesting animations and attractive graphics, as well as a means for presenting images from videodiscs or an attached video camera for "live" images. Similar in many ways to HyperCard, HyperStudio utilizes the metaphor of a stack of cards: each card may be constructed by adding text objects, graphics (either drawn with the paint tools, any PICT, or a "freeze frame" from a video input), and buttons which create an action. Buttons can be used to play prerecorded sounds (including those from an attached CD-ROM player) or sounds recorded by the preparer. Buttons also can cause a video to be played on the screen; this can be video from a laserdisc player, from an attached camera, or from a QuickTime movie. Likewise, animations of any object (PICT or drawn) can be created.

HyperStudio has been used successfully with students in many classrooms and has demonstrated itself as a viable authoring tool for courseware development. The following screen-shot depicts the opening "Home Stack" of HyperStudio with its various choices.

This opening menu provides a short tutorial on HyperStudio ("What is HyperStudio") and some examples of stacks, varying from the very simple, which incorporate text, simple buttons, and graphics, to the more complex, which incorporate sounds, videodiscs, and QuickTime movies. "Clip-Art and Clip-Sounds" may be incorporated into any new stack. A unique feature of HyperStudio is included in "Sharing Your Projects!": a HyperStudio player can be saved onto disk to accompany a new stack for sharing with others. Finally, the "Special Stacks" permit the user to create a custom designed "Home Stack."

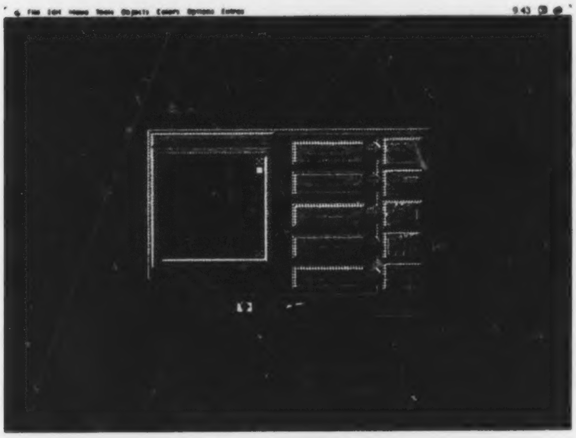
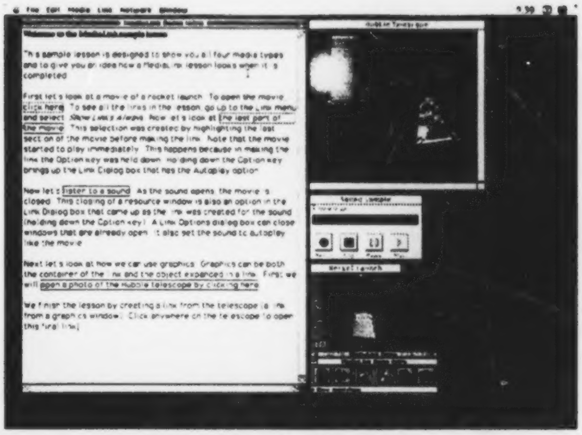


Figure 1. HyperStudio

MediaLink 2.0

An intriguing newcomer to the world of hypermedia authoring, MediaLink is easy to use and it incorporates several media types (text, sound, graphics, QuickTime movies, and linking of these elements). Yet MediaLink has a number of unique features which sets it apart from the many authoring packages available: it permits annotation of text by incorporating any of the media types above, seamlessly linking them through drag-and-drop techniques. Furthermore, MediaLink permits collaboration on a project via an AppleTalk or TCP/IP network: individuals may prepare lessons at the same computer, or at the same site, or over long distances by way of a normal Internet connection. This collaboration component works well in an introductory computer course in which students are more comfortable learning from each other by collaborating on course assignments. Furthermore, as one wishes to draw from resources residing at another location (e.g., a collection of historical images to be scanned; interviews with individuals), this ability to work together over long distances enhances the production of an effective lesson or project.

Figure 2 is a screen shot from a demonstration lesson prepared in MediaLink. This illustration depicts a MediaLink text window with its links shown to various media types: a photograph of the Hubble telescope, a sound sample, and a QuickTime movie of a rocket launch. Additionally, a strip of buttons for opening windows for text, sound, pictures and movies is included. The telephone button permits one to collaborate with another via the telecommunications choices mentioned above.



Welcome to the MediaLink sample lesson

This sample lesson is designed to show you all four media types and to give you an idea how a MediaLink lesson looks when it is completed

First let's look at a movie of a rocket launch. To open the movie click here. To see all the links in the lesson, go up to the Link menu and select Show Links Always. Now let's look at the last part of the movie. This selection was created by highlighting the last section of the movie before making the link. Note that the movie started to play immediately. This happens because in making the link the Option key was held down. Holding down the Option key brings up the Link Dialog box that has the Autoplay option

Now let's listen to a sound. As the sound opens, the movie is closed. This closing of a resource window is also an option in the Link Dialog box that came up as the link was created for the sound (holding down the Option key). A Link Options dialog box can close windows that are already open. It also set the sound to autoplay like the movie

Next let's look at how we can use graphics. Graphics can be both the container of the link and the object expanded in a link. First we will open a photo of the Hubble telescope by clicking here

We finish the lesson by creating a link from the telescope (a link from a graphics window). Click anywhere on the telescope to open this final link)

Figure 2. MediaLink 2.0

Summary

MediaLink and HyperStudio both fulfill the criteria for appropriateness of hypermedia authoring packages. Both offer ease of use by teachers and students at any level. Both provide for the integration of a variety of media types, including sound, graphics, movies, and hypertext. And, while currently designed for the Macintosh, both are under development for the Windows platform. HyperStudio continues its tradition of offering sophisticated tools for the easy preparation of interactive lessons and presentations. The newcomer MediaLink offers similar sophistication and ease of use along with the added dimension of networking with others for collaboration, including via the Internet. Both HyperStudio and MediaLink offer educators the freedom to produce elegant and effective hypermedia lessons and presentations.

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Educational Multimedia and Dewey's Reconstruction of Experience: Practical Considerations

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The Dewey School

Next year will mark 100 years since John Dewey founded the University Elementary (or Laboratory) School at the University of Chicago. This school was established to test in practice the value and meaning of his ideas for the study and improvement of education. Additionally, Dewey's interest in the education of his own children influenced his decision. When Dewey was once asked what led him to found the school, he replied, "It was mainly on account of the children" (Mayhew, 1965, p. 446). While the span of Dewey's life (1859-1952) covers a period of dramatic change in American history, it is unlikely that he could predict the technological changes in education and society to which his children and grandchildren would be exposed.

Dewey and Modern Instructional Technology

The humble Laboratory School housed in various residences near the University of Chicago campus marks a stark contrast to the ultra modern schools of today with their computers, fiber optic networks to the world, laser discs, interactive compact discs and other multimedia authoring and presentation devices. To what extent are Dewey's views on schooling relevant to current issues and problems in education today? Would he see the technological wonders available to today's teachers as tools to further significant learning? Or, would current technology be seen as meaningless trappings that support the "teacher-as-transmitter" model? It is clear that he thought little of contemporary education which he called "old education." The "old" education treated the child as an essentially passive creature upon whom the teacher imposed information and facts. Dewey's views and his school represented a radical departure from educational thought at the time. Bernstein described Dewey's approach this way:

> Dewey sketched a new way of viewing human behavior as consisting of active coordinations in which conflicts arise that necessitate reconstruction. ...The child, who is a naturally curious and active creature, was to be educated in such a way as to take advantage of this exploratory activity. (Bernstein, 1966, p. 39).

The natural growth and unfolding of children's interests were central to his philosopohy of education. His voluminous writings on society and education speak, in detail, to many facets of the human condition and to the proposals for a better conception of schooling. This paper will focus on instructional technology development and delivery as it relates to a central concept in Dewey's thinking; the idea that education is the reconstruction of experience.

Education as the Reconstruction of Experience

Dewey often contrasted the 'old' education as subject-centered, rote learning with passive students to his notion of child-centered, purposeful learning with active students. Active students needed to encounter experiences to grow and develop. In one of his most famous works on education, *Democracy and Education*, he says:

> ... the ideal of growth results in the conception that education is a constant reorganizing or reconstructing of experience. ...We thus reach a technical definition of education: It is that reconstruction or reorganization of experience which adds to the meaning of experience, and which increases ability to direct the course of subsequent experience. (Dewey, 1944, p. 76)

Education of this type contrasts sharply with procedures which start with facts and truths that are outside the range of the experience of students. A fundamental condition which gives rise to learning is the student interacting with the world. There is an exchange, an undergoing that leads to a fuller and richer understanding. In his book, *How We Think*, Dewey stated it this way:

> Experience is not a rigid and closed thing; it is vital, and hence growing. When dominated by the past, by custom, and routine, it is often opposed to the reasonable, the thoughtful. ... Indeed, the business of education might be defined as an emancipation and enlargement of experience. (Dewey, 1933, p. 202)

It would be a mistake to believe that the principle of one experience leading to something different is automatic and adequately satisfied simply by giving students some new experiences. Interest and purpose come into play too. Dewey believed interest is what leads a student to new experiences, deeper meaning with wider knowledge. (Wirth, 1966, p. 94) Mayhew and Edwards in their book about the Dewey School include this comment on experience and interest:

> No experience is truly educative unless interest and effort go hand in hand toward a desired goal. An interest is a form of self-expressive activity which has an objective end (idea or object) in view. This has felt value, and its attainment gives satisfaction. In a young child action is direct and immediate. (Mayhew, 1965, p. 421)

Equally important in this view of education is the role of purpose in thinking about experiences and activities for students. Students are seen as curious, active and purposive beings. Teachers should be considered guides who help the student to achieve his or her own purposes. While purpose may start with an impulse, it is clear that Dewey saw purpose as a more complex set of interactions. In *Experience and Education*, which he published in part to clarify some of his key principles of education, he says, "A purpose differs from an original impulse and desire through its translation into a plan and method of action based upon foresight of the consequences of acting under given observed conditions in a certain way." (Dewey, 1938, p. 69) A series of activities in which the learner had little choice and is essentially a passive actor, does little to further the growth or the student or lead to new more meaningful experiences. The activity has to involve the student in a way that requires a *reconstruction* of the experience.

Occupations

Any discussion of the Dewey school, his ideas of interest, experience and purpose lead to the desire for more concrete detail with regard to how these concepts were brought to life in the everyday activity of the school. He settled upon the term "occupations" to describe the central activity or subject-matter of the school. Identifying and describing occupations proved to be a continuing problem for Dewey and his followers. Occupations represented perhaps the most dramatic departure from traditional schools, and remained the most difficult to understand. Dewey had this to say about occupations in *How We Think:*

> ... the most serious of all problems is ignored: the problem, namely, of discovering and arranging the occupations (a) that are most congenial, best adapted, to the immature stage of development (b) that have the most ulterior promise as preparation for the social responsibilities of adult live; and (c) that, *at the same time*, have the maximum of influence in forming habits of acute observation and of consecutive inference. (Dewey, 1933, p. 52)

Occupations, it should be immediately noted, have little or nothing to do with careers or jobs. Occupations were seen as processes. They might include such activities as gardening, sewing, cooking, carpentry as well larger occupations outside the home to include farming, mining and lumbering. Later the students would study the process involved in industry, invention and discovery. The study of fundamental process included actually doing gardening or cooking or simulating an activity such as building a model project of a mill or barn for example. The occupations were devices to allow students to experiment and to expand their experiences and studies. We have to remember that all of this was carried out in several make-shift school buildings that consisted of converted residences. Mayhew and Edwards describe the school conditions this way:

> In justice it should be said that at all times the experiment was much hampered by its limited quarters and equipment. Because of the lack of library and laboratory facilities especially, many of the things done with the three older groups were second choices as to subject-matter. The very nature of the school also made it necessary for the children to concentrate under difficult conditions of noise and interruption. ...Lack of a library, lack of quiet, lack of beauty, lack of adequate space for club meetings, all made it impossible to carry out many individual and group plans. (Mayhew, 1965, p. 248)

This description of the Dewey school by Mayhew and Edwards contrasts sharply with the image we have of today's ultra modern structures with spacious specialized rooms equipped with an impressive array of computers and other instructional technology. In spite of the physical differences in school buildings, it is possible to apply some principles and insights from Dewey's educational ideas developed many years ago and relate them to questions and problems facing the development and use of technology in teaching and learning today. We need only to look at the recent literature in instructional technology design to pick up on the debate over the proper approach to instructional technology strategies.

Constructivism

While Dewey used the concept of *reconstruction of experience* to describe the fundamental process of education with children, current theorists use a very similar term, *constructivism*, to describe the philosophic and theoretical basis of instructional design. In their discussion of the contrasts between objectivism and constructivism, Duffy and Jonassen underline the importance of experience in learning.

Constructivism provides an alternative epistemological base to the objectivist tradition. Constructivism, like objectivism, holds that there is a real world that we experience. However, the argument is that meaning is imposed on the world by us, rather than existing in the world independently of us. There are many ways to structure the world and there are many meanings or perspectives for any event or concept. (Duffy and Jonassen, 1991, p. 8)

This sounds very much like the debates Dewey had with his contemporaries and the prevailing theories of learning based on realism and idealism. Later in their article the words of Duffy and Jonassen sound even more like Dewey's earlier description of the role of reconstruction in learning. They state:

> Instruction, in turn, should not focus on transmitting plans to the learner, but rather it should focus on developing the skills of the learner to construct (and reconstruct) plans in response to the situational demands and opportunities. ...A plan is one part of that sense making, but plans must be constructed, tested, and revised as a function of the particular encounters in the environment.(Duffy and Jonassen, 1991, p. 9)

As with Dewey, this approach stresses the active role of the learner. The learner is a processor of information. The student elaborates, expands upon and interprets information and experiences. The idea of the active side of the learner is expanded by Perkins in a companion article in *Educational Technology*. "Understanding is not something that comes free with full databanks and thorough practice; it is something won by the struggles of the organism to learn—to conjecture, probe, puzzle out, forecast, and so on." (Perkins, 1991, p.21)

Construction Kits

Another helpful description of the facets of a learning environment from a constructivists view is provided by Perkins when he described one of these facets as "construction kits" Traditional construction kits might include Legos, Tinker Toys, Lincoln Logs, and Erector Sets. He says virtually any laboratory apparatus provides a construction kit. The concept can be expanded to include advances in instructional technology which has given us a whole new range of construction kits. Simulation software, database and spreadsheet programs, network tools, and authoring programs all provide rich resources and construction kits for today's student. (Perkins, 1991, p.19)

A Paradigm Shift

Cooper (1993) makes a strong case for the shift from the early behaviorist work of Skinner and others in programmed instruction to prevailing constructivists theory of designed instructional technology. He too notes that reality is determined by the experiences of the knower and that internal processing is essential in a constructivists view. "For the constructivist, learning is problem solving based on personal discovery, and the learner is intrinsically motivated." (Cooper, 1993, p. 17) If designed instruction has moved away from behaviorism and the ideas provided by Skinner to an emphasis on constructivists' principles, it could also be seen as grounded in principles Dewey enunciated at an earlier time. Dewey's insistence on pupil interest and purpose noted earlier in this paper sound like the idea of "personal discovery" mentioned above by Cooper. Additionally, Dewey stressed problem solving as central in the curriculum. His occupations were processes in which students would encounter roadblocks, dilemmas, felt difficulty and problems to be solved.

John Dewey's writings on education and in particular his ideas of education as the reconstruction of experience now seem to have found new advocates in the constructivists' camp. His ideas were often rejected or ignored because of misunderstandings or because of the radical departure from prevailing educational theories. Constuctivists principles need to remain receptive to other perspectives, including behaviorism, so as not to devalue the contributions and appropriateness of those ideas. Cole (1992) argues that there should be a search for a common ground in these traditions and they might best be seen as a continuum. (Cole, 1992, p.28) She suggests that, "We must focus our attention on finding ways whereby we can identify the process and products of learning at every point on the continuum, scaffolding and coaching learners as we help them negotiate the world.." (p.29) Dewey would no doubt find Cole's statement completely consistent with his own views. Dewey's fundamental belief that education is the reconstruction of experience and the more recent constructivist postulates regarding learning and instructional technology are essentially saying the same things, How then, would this influence practical decisions in the development and use of the current technologically based hardware and software construction kits?

Practical Considerations

The daily work of a teacher who designs or uses instructional technology, whether it is a complicated interactive multimedia program or a simple piece of computer software, must make decisions and choices based on the intended student learning. Decisions based on constructivists' principles result in a student role that is active, engaging and deeply involved in the learning process. The teacher cannot assume that learners will actively seek out information from software or hypermedia programs. Lee and Lehman (1993) showed this quite convincingly in their study of instructional cueing. Students classified as active learners consistently performed better than did students' classified as neutral or passive learners. Improved performance for neutral and passive learners resulted when they were *forced* to become active by the instructional cues provided in the hypermedia program. (p. 35) Hints, cues, and other devices which engage the student as an active participant, problem solver, developer, and author should be considered. Literally thousands of media products are now on the market begging for a place in school programs. It is helpful to look at some examples of media and technology which would find favor with constructivists' views and be compatible with Dewey's educational philosophy.

Examples

Foxfire, the cultural journalism model developed by Eliot Wigginton in rural Georgia, engages students in purposeful activities while using simple tools of tape recorders and word processors Students research Appalachian customs and practices and develop articles for their Foxfire magazine. Edwards and Orlando (1989) explain a similar idea for oral history which includes the use of word processing and the development of a data base. They offer a step-by-step plan for the oral history project. It allows the student to become interviewer, author and developer while organizing recording, writing and reporting their oral histories

Mendrinos (1989) explains how students can use word processing, a data base program and a spread sheet to better understand the Third World. "...students manipulate, analyze, and rework the information creatively into a realistic fiction. In effect, they become personally involved and are encouraged to draw conclusions from the data researched" (p. 34)

The Taliesin Project is described by Smith and Westhoff as an innovative curriculum materials and development effort. (Smith and Westhoff, 1992) Mathematics, science and technology for grades six through eight comprise the focus of this project. They state that one of the goals of this project is, "...the development of a computer-aided classroom instructional tool based upon hypermedia technology."(p. 15) Emphasis is placed on active learning through the use of real-world examples and experiences in the media rich curriculum. While an impressive array of technology is a part of the plan, the instructional model has a student involvement focus.

Picciano (1993) described the Five Points project at Hunter College as a multimedia experience in social history. One of the major objectives of the program was, "... to involve the students in an activity wherein they could explore and develop their own ideas and opinions of social group conflict and its causes." (p. 133) He contends that most multimedia materials do well at motivating and informing learners while failing to involve them. It was an explicit goal of the Five Points design to facilitate learning with events which would motivate, inform *and* involve the users.

Simulation programs like Oregon Trail, Golden Spike, and the Sim series require heavy student involvement and decision making as they enter the simulated environment and construct meaning from it. Problems are posed which must be solved. Decisions must be made. Involvement is required in these programs.

Perhaps the best examples of technological construction kits which illustrate Dewey's belief in education as the reconstruction of experience or constructivists principles, are authoring and development tools such as HyperCard, ToolBook, Authorware, HyperStudio and similar programs which allow users to process and present information and experiences in creative ways. These are just a few illustrative examples of current technology which would seem to fit the reconstruction of experience idea.

Summary

Founded nearly 100 years ago, the Laboratory School at the University of Chicago served as an experiment to test the educational ideas of John Dewey. Education as the reconstruction of experience was central in Dewey's principles of education. Study of a range of human activities Dewey termed occupations, made up the major portion of the curriculum of the school. The physical setting, available materials and general conditions at the school were primitive compared with the ultra modern, technologically equipped schools of today. In spite of these vast differences in time, setting and materials, Dewey's ideas seem to easily fit with and support current instructional technology design thinking. Constructivists' writings appear to embrace many of Dewey's basic principles including the belief in the active, involved learner as essential to successful instruction. Designers of multimedia programs and instructional technology and users of these programs might benefit by thinking of education as the reconstruction of experience as a guiding principle.

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Beethoven's a Dog; Rafael's a Ninja Turtle; Should Rembrandt be a CD-Rom?

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First it was a film about Beethoven. But Beethoven is a dog! And then there were the Leonardos, Michaelangelos and Rafaels. But they were turtles! No one seemed to complain that the names of great artists had been demythologized. But CD came to the rescue! The real resurrected Beethoven hit the CD Market as one of the earliest, and the real resurrected Leonardo is now here. But what about Rafael and Remington and Rembrandt? Yes, what about Rembrandt?

Voyager had already recorded the Louvre with its sixteen Rembrandts and Lumivision followed with the Hermitage and thirteen of its Rembrandts in CAV videodisk format. Both allow freeze frame browsing but with the resolution of the analog TV screen. Microsoft completed the British National Gallery with twenty five Rembrandts and New York's Frick Museum contracted its collection with three Rembrandts to CD. And both suggest using CD displays with 250,000 colors to show those works. For browsing in art, and for teaching in art the teacher needs to display with a 1,000,000 colors, and for group work the alternatives are LCD panels, projectors and the large Mitsubishi monitor.

Enough for display! What is programmed on many CDs, is not readily workable for teachers. They are encyclopedic and fine for browsers but not readily adaptable to the time and space programming of the teacher. CDs of the future, if they are to provide anything beyond independent learning in students need to provide a linear story line approach to their content. But why?

Understanding how humans learn makes clear the importance of both a browsing and linear story line format. Every learning situation is a mapping or moving from multi-sensory experience, to selective perception of an individual experience, to the linking or relating of several experiences in a given time-space context.

As a browser you open up a CD and make a series of choices which take you down a linear story time road of your own choosing. Like a film director, or comic strip writer, you arrange in a time-space context those different experiences. And for every choice of experience you make the linear story line different.

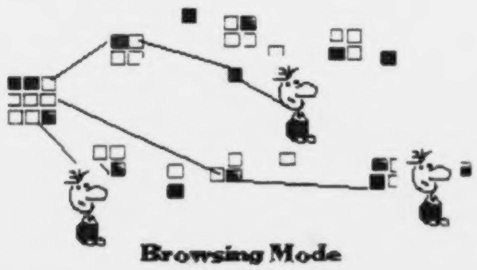
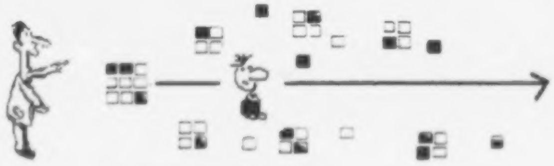


Figure 1.

However in a teaching process the teacher determines by outcome based criteria the time and space sequence of data as that data is open to interaction between members of a large group. The teacher like the advertiser can not allow the "sell " to chance or to whim! The teacher arranges those experiences in such a way as to motivate and to sell.



Linear Story Mode

Figure 2.

The design of browsing materials and instructional class process materials must be different. Since you can read the browsing materials slowly, they can contain more text than graphics. However in the interactive teaching process you need faster pacing, a bias of graphics over text, and some sound clues. A well constructed CD could be used with a linear story narrative and then inspire students to browsing before, during, or after the interactive group learning.

Both browsing and group learning are important. Browsing liberates the student so that she is totally responsible for her own motivation inspiration, and the choice of roads traveled. On the other hand a good teacher with multimedia tools can provide motivation and facilitate group motivation through the use of an interactive linear story line. The source of the motivation is different in both, and the control of mapping strategies is different.

How could you do that with Rembrandt? How could you display well his paintings; how could you provide an exciting linear story line for multi-media teaching? How could you incorporate browsing materials for the avid learner? Using Macromedia Director to insure the 1,000,000 color display of the experiences I have provided two linear story narratives, "His Story," and "In Search of the Real Rembrandt."

In the story line important moments are arranged to provide a biographical role model for students, with a punctuation with video sequences from videodisk. And the sequence itself reflects the objective, that students will identify obstacles and opportunities used by Rembrandt to develop his gift. A companion browsing section, "Timeline" provides a tight sequence of events in capsule form. Another linear story line details the process of authenticating of his painting, drawing, and etching. There are five others which deal with his different painting genres, portrait, history, Biblical, Christian, family works. Companion pieces to the painting sections are two browsing sections in etchings and drawings. Two final browsing sections present resources important to Rembrandt's self realization, and museums which celebrate his greatness.

The major concerns for the development of a CD would be to provide at least one linear story narrative which is objective driven and which follows a linear historical narrative with reinforcement from the central screen and menus on the right. This CD has two of them, one dealing with Rembrandt, and another with his works. The other ten browsing sections provide more than enough stimulus for the hooked CD user.

In 1992 the Rembrandt Research Project published its third book identifying authentic Rembrandt paintings. One critic of the project complained that the group's basic thesis is to reduce the number of authentic paintings so that Rembrandt is easier to understand. And he added, "Rembrandt does not belong to the critics; he belongs to all of us." This CD will insure that in the near future, he will really belong to all of us.

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Beginner's Guide to Multi/Hypermedia Development with Visual BASIC

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The arrival of Visual BASIC (VB) heralds yet another shift in the dynamic between the ease of learning/ease of use provided by authoring languages and the flexibility and power offered by general purpose programming languages. Until recently, authoring languages were the only realistic option for many educators who were interested in the development of event–driven hypermedia and multimedia applications on the Windows platform. The production of almost any application of this nature using the existing high– level languages was extremely complex. Such is no longer the case. Visual BASIC provides the Windows programmer with an extensive set of tools for making sophisticated Windows programming an approachable task. This paper will describe Visual BASIC multimedia and hypermedia techniques that compare very favorably with authoring tools in terms of simplicity and ease of use.

Why Does Visual BASIC Interest Developers of Computer-Based Instruction?

Visual BASIC (for Windows) is a programming tool for developing applications that operate in the Windows environment. (There is also a DOS version to which this paper should not be assumed to generalize.) Unlike authoring languages and systems, which are optimized for the development of computer–based instruction, VB is a general purpose programming language that supports the development of a wide variety of applications. However, the same object–oriented design characteristics that make VB the easiest high–level programming language yet developed for Windows (Cafolla & Kaufman, 1994) also suit it for use in the development of computer–based instruction (Chapman, 1994).

What Are Visual BASIC's Multimedia Capabilities?

Obviously, it is impossible to understand Visual BASIC without first understanding the features and protocols of Windows. Similarly, an understanding of the multimedia capabilities of VB begins with understanding the multimedia capabilities of Windows. This information is most easily accessed by running the Windows Media Player located in the Accessories group. As illustrated in Figure 1, the Media Player shows what multimedia resources are available on a specific system. The computer used to write this article had a CD ROM drive and a sound card installed. Also, software had been installed to allow playing of audio CDs, playing of MIDI files, playing of Video for Windows (AVI) files, and playing and recording of sound files in *.WAV format. A laserdisc player is another popular option, but this computer did not have one installed. The process of installing media software and hardware is beyond the scope of this article. What is important to note here is that VB will allow you to access whatever multimedia Windows will allow you to access.

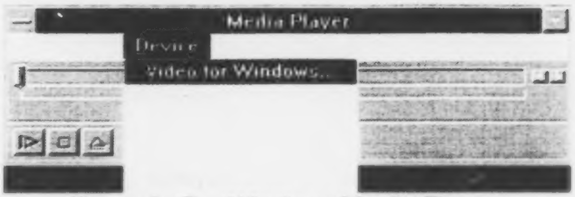

Figure 1. The Windows Media Player.

Olé for Visual BASIC Multimedia!

The easiest way to put multimedia in a VB program is the same way that it can be accomplished in many Windows applications — *Object Linking and Embedding (OLE)*. The icon for selecting the OLE control is labelled *OLE 2.0* and can be observed at the extreme left of Figure 2.

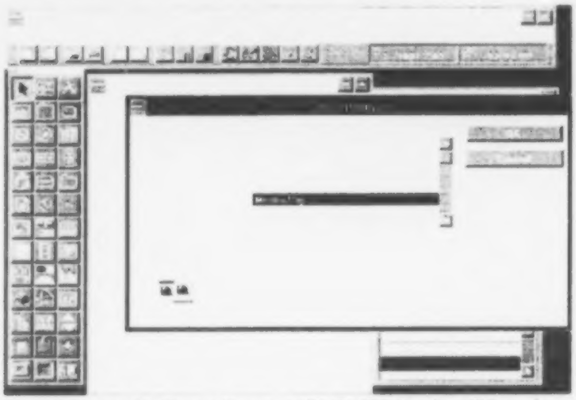

Figure 2. Creating a VB OLE Media Clip.

Figure 2 also indicates the first thing that happens when the programmer selects the OLE control for inclusion on a form — the programmer must indicate what type of object is to be embedded. In this case, a *media clip* has been selected. Selection of the media clip option causes the launching of the Windows Media Player, as indicated in Figure 3.

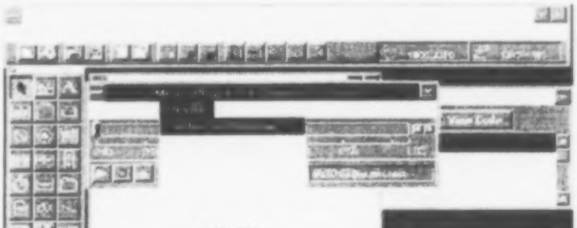

Figure 3. Selecting the CD Audio Device.

The programmer then selects the media device and file (if necessary), as one would if using the Media Player directly from Windows, and then exits the Media Player object. As Figure 3 also indicates, in this example the CD Audio device has been selected. Figure 4 illustrates the final result: a VB form into which a multimedia object has been embedded. (Notice in the properties window that the appearance of the OLE object has been altered by changing the *SizeMode* property to *AutoSize*). When this VB program is subsequently executed, the user is able to play an audio CD by double-clicking the OLE icon.

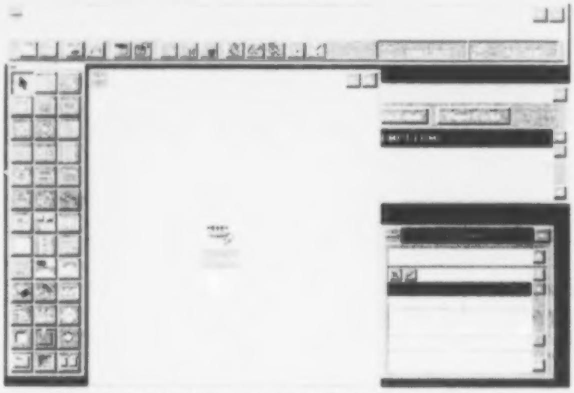

Figure 4. A Completed OLE Object in VB.

Multimedia Via the Windows API

The example above was produced with the Professional version of VB 3.0, which makes it very easy to use OLE. In older versions of VB, especially the Standard versions, OLE is not usually so easy to implement. To get similar effects, you may have to call functions in the Windows Applications Programming Interface (API). In Figure 5, the button labelled *MCI* has the code shown in the lower code window attached to its click event. This code causes the API to play an AVI (a digitized movie with sound) file named *sample1.avi* located on the C: drive. In order for this code to work, the *mciExecute* function must first be declared, as illustrated in the upper code window.

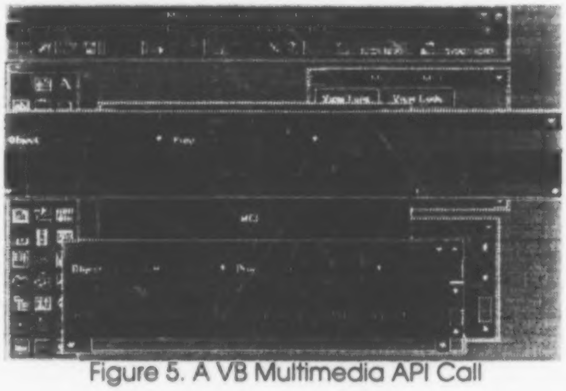

Figure 5. A VB Multimedia API Call

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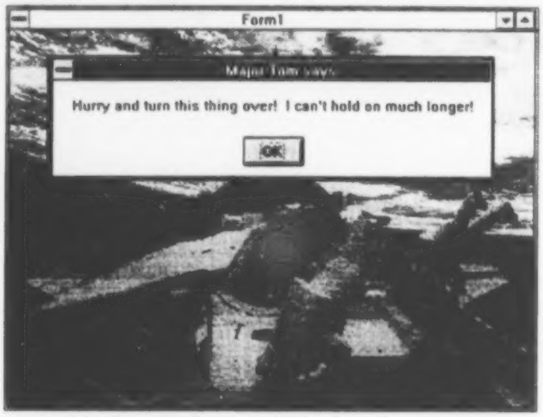
How Is Hypermedia Accomplished Easily in Visual BASIC?

As illustrated in Figures 1 through 4 (e.g. clicking on the icon caused information to be accessed), some elements of hypermedia are inherent in VB. Other simple techniques are easily accomplished. Figure 6 illustrates an informative message box that pops-up when a *hot spot* (the leftmost astronaut) is clicked.

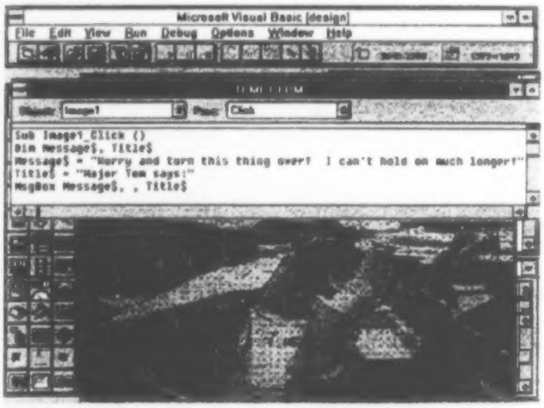


Major Tom says:

Hurry and turn this thing over! I can't hold on much longer!

Figure 6. VB Message Box Invoked by Clicking a Hot Spot

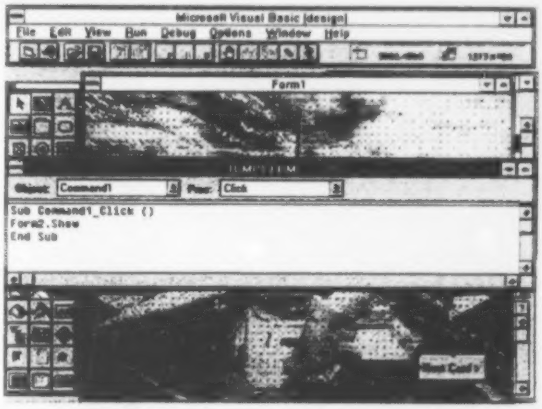
The shuttle picture (downloaded from the Internet and converted from GIF to BMP format) was incorporated into the VB form by setting the form's *Picture* property. Then an *Image* object (the Image control is right above the OLE 2.0 control at the left of the illustration in Figure 7) was placed on the form and sized to fit the astronaut. The outline of Image1 can be seen around the astronaut in Figure 7. Since the Image1 object's picture property was given no value, the object remained transparent. Code was then attached to the object's *click* event, also illustrated in Figure 7. The purpose of the code is to invoke the message box seen in Figure 6. The reader will note the very small amount of code required to create the message box with default OK button.


Microsoft Visual Basic [design]
File Edit View Run Debug Options Window Help
Object: Image1
Proc: Click

```
Sub Image1_Click ()
Dim Message$, Title$
Message$ = "Hurry and turn this thing over!  I can't hold on much longer!"
Title$ = "Major Tom says:"
MsgBox Message$, , Title$
```

Figure 7. VB Code for Hot Spot Click to Invoke Message Box.

As a second illustration of VB's hyperprowess, Figure 8 illustrates how the code attached to a command button can invoke a jump to another card. A new button labelled *Next Card >* has been placed on the form near the bottom right. As the code window indicates, when the button is clicked the target form (a theoretical *Form 2*, containing additional information) is brought to the forefront merely by instructing it to *Show* itself.


Microsoft Visual Basic [design]
File Edit View Run Debug Options Window Help
Form1
Object: Command1
Proc: Click
Next Card >

```
Sub Command1_Click ()
Form2.Show
End Sub
```

Figure 8. VB Code for Using Button Click to Jump to Another Form.

Conclusion

The goals of this paper were met in the simple fact of its completion. The author, although experienced in procedural programming, had very little knowledge of Visual BASIC and yet was able to produce this admittedly rudimentary and possibly ill-informed exposition of VB hypermedia in very short time. Hopefully, the reader will be encouraged to attempt the same.

There are some obvious shortcomings in using VB as an authoring tool. For example, any authoring software worth using has a simple means of placing a generic *go-to-next-card* button on a base page. As a further example, the better authoring programs also provide special facilities for answer evaluation and data management. As a general purpose Windows development language, VB has no such features (so far as the author was able to determine). However, VB's object-orientation means that the language is easily extended via Visual BASIC Extension (VBX) files created by Microsoft or by third parties. There are already many such third party VBXs available for a wide variety of purposes. Given sufficient demand, possibly some enterprising programmer will create an authoring VBX.

There is certainly much more to this subject than the cursory look taken in this paper. For additional information on the methods discussed here, and much more, the reader is referred to the texts listed in the references. Jarol's (1994) book on VB multimedia was especially helpful and came with a CD full of valuable example programs and resources, not the least of which was the complete Video for Windows development software.

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Repurposing the Level II Alberta Videodiscs for Level III Use

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In 1993, the Houston Consortium of Urban Professional Development and Technology Centers received a grant from the Texas Education Agency to develop and implement a new teacher education program based on two major innovations: (1) teacher education would become site-based in professional development schools that were partners with the four teacher education institutions in the consortium, and (2) the programs would be "technology rich." Four institutions - Houston Baptist University, Texas Southern University, University of Houston, and University of St. Thomas - are all members of the consortium. A component of the grant was the Teacher Education Development System (TEDS) that was to develop technology-based training materials such as teacher education laserdiscs. In the original grant, TEDS was allocated approximately $450,000 to develop a series of four to six computer-supported videodisc packages that would be used in the new programs. Each would contain approximately 30-minutes of classroom video that was shot in Houston-area schools and edited for the videodisc by TEDS staff at the Center for Information Technology in Education, University of Houston. However, when TEA actually awarded the grant, the funds were far less than requested and in a revised budget for the consortium the budget for TEDS was cut to approximately $100,000. It became clear then that we could not complete all the work required to produce even four original videodisc packages on the new budget and we decided to explore options for "stretching" the budget to provide technology-based instructional materials for the consortium. Two new videodiscs were produced (see the paper by Elizabeth Stephens in this book for information on the software/video package). An original CD-ROM of instructional materials and resources was also developed and distributed (the *First Teacher Education CD-ROM* is available from AACE, the publisher of the Annual). Additionally, a collaborative partnership was formed with Cleveland State University to complete work on two videodisc packages developed by Cleveland State professor Ron Abate. TEDS staff worked with Dr. Abate to create a teacher's manual and Dr. Abate revised the software used with the two packages. Those two computer/videodisc packages were distributed to the consortium and are also available nationally through the Association for the Advancement of Computing in Education.

Converting Level II Videodiscs

A third approach to stretching the available funds involved repurposing teacher education videodisc packages that were created elsewhere but could not be used on equipment available at the consortium's four universities. The University of Alberta, College of Education, developed two video tutorials on laserdisc: *Classroom Management: A Case Study Approach* and *Do I Ask Effective Questions?* As the titles suggest, the content involves discipline problems and the use of questioning as an effective teaching strategy, respectively. These discs are designed for Level II laserdisc players.

They contain programming code at the front of the disc that is loaded into a Level II videodisc player each time the disc is used. Once the software is loaded, students can complete the simulations and tutorials on the disc using the remote control for the player. When the Alberta discs were created in the mid-1980s, many people felt Level II players would soon be widely available while computers for controlling Level III videodiscs might not be readily available in many teacher education programs. Unfortunately, the reverse is true today. Very few teacher education programs have Level II players while most have regular players such as the Pioneer 4200 as well as Macintosh computers that can control the player. In fact, the Houston Consortium purchased powerful Macintosh computers and Pioneer laserdisc players for each institution.

Level I, II and III Laserdisc Players

Each type of laserdisc player offers a different mode and complexity of interface between the learner and video content. Level I players have the most limited interface capabilities of the three, relying on either manual input of standard remote control functions such as a specific frame or chapter number, or bar codes and a bar code reader, to move through the video content. Level III players contain an RS-232 or "serial" connector and can be connected to most personal computers with the proper cable. In this configuration, the player is controlled by the software residing on the computer, and the user interacts via a keyboard and/or mouse. The interface embedded on a level II laserdisc is inaccessible to Level I and III players. Consequently, when the Alberta videodiscs are played on a Level II computer the student sees an orderly sequence of instruction screens, informational video clips of a professor discussing a concept, classroom video that stops at critical points, and choice screens that ask you to decide between a series of choices displayed on the screen. Attempting to view the Alberta videodiscs on a Level I or Level III player produces a dizzying rush of stills, text, menus and motion segments. The Alberta videodiscs were of interest to a number of teacher educators in the consortium and the TEDS group decided to write the software needed to convert the discs to Level III use.

Choices Made in the Conversion Process

Hardware

The hardware configuration of a level III setup can include either one or two screens. In a two screen set-up non-video information, such as menus and help text, appears on the computer screen while video content is displayed on a TV monitor connected to the laserdisc player. In a one screen set-up a video overlay board is installed in the computer enabling display of the video content on the computer screen along with menus and help text. The target audiences for this project do not have computers with overlay boards. therefore, the conversion to Level III was designed for a two screen setup.

Interface

Conversion of a Level II laserdisc interface to Level III highlights important elements of interface design such as ease of use and the minimization of backward searching. In a level II interface, placement of video content across the laserdisc is strongly influenced by the need to physically move forward through the disc while giving the appearance of random access. To maintain smooth and consistent progress, branching is kept to a minimum in order to keep search time down. Content is often repeated throughout the disc: for example, menus, still frames and help text are duplicated where needed on the disc to avoid requiring the software to branch back to an earlier part of the disc to display a frame of text or graphics.

In a Level III environment, video menus and help text frames need not be placed on the videodisc because the information can be displayed instead on the computer screen. Design of digitized menus and text can draw from a wider range of color, fonts and graphics, expanding the look of the interface to include attractive, instruction-enhancing multimedia elements. The expanded functionality provided by a keyboard, mouse, and the potential branching power of computer software, widens design parameters to include such features as perpetually available pull-down help menus, simultaneous display of supportive textual information and full motion video segments, and increased branching and exiting ability, without necessarily increasing laserdisc access time.

With the increase in design possibilities comes the potential to alter the instructional strategy implied in the original interface. However, the Alberta laserdiscs, are highly structured, program-controlled simulation-tutorials, where correct behavior is explicitly stated or modeled, and the learner is required to identify appropriate and inappropriate examples or responses before being allowed to proceed, or exit.

With these considerations in mind, the mode of interaction, color scheme, standardized screen layouts and fonts were determined. A separate color scheme was chosen for each laserdisc. A medium intensity hue was chosen as the primary background color, with two or three lighter and darker shades used to create a three dimensional effect in the video control panel and border. Separate fonts were selected for menus and help text. The menus consist of a title, several buttons and a one-line directive to select an option (see Figure 1). Help text was provided in pull-down menus. A video control panel was designed to appear at the top of every screen, through which the user controls the video by clicking with a mouse on buttons that replay segments, switch between sound channels, stop a video segment, and still-step forward or backward. An important consideration in the design of the control panel was the need to give the novice computer user enough confidence to use the software with minimal instructions. (see Figure 2)

Development

Flowcharts

Flowcharts of the Level II interface were graciously provided by the University of Alberta, College of Education without which conversion would have been impossible. The xt scrd

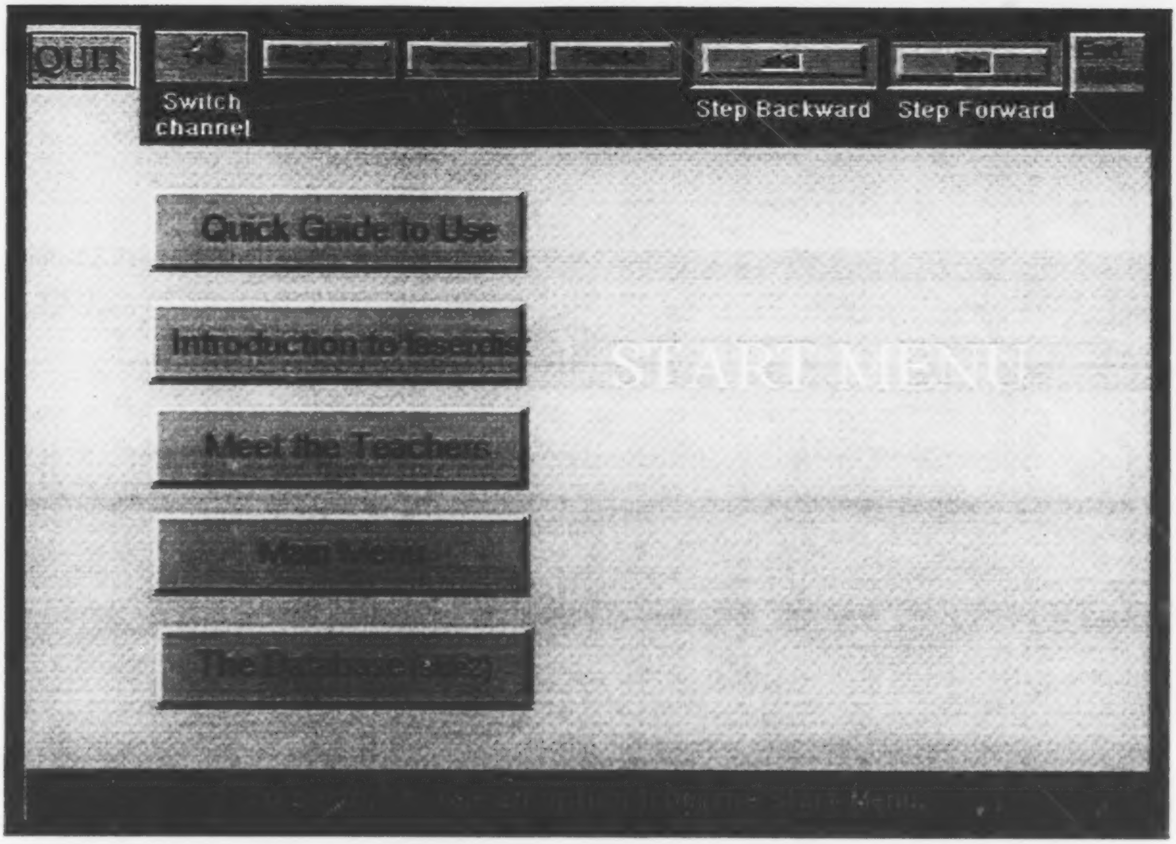

Figure 1. Startup Screen for "Do I Ask Effective Questions"

The laserdisc tutorials are predominantly a series of menus, text screens, and video segments. Decision points, branched pathways, and process boxes containing frame numbers, make up the bulk of the flowcharts. Once the "look and feel" decisions were made and the interface designed, converting these elements into instructions in the software comprised a major portion of the conversion process.

The Authoring Environment: Authorware Professional

The authoring environment selected for this work was *Authorware Professional*, which is available in versions for both Macintosh and Windows. The primary way of writing software using *Authorware Professional* is a set of icons, each of which performs particular functions related to displaying information, waiting for user input, branching, and communicating with the laserdisc player. Thus, translating the Alberta flowcharts was a relatively simple but time-consuming process of identifying corresponding Authorware icons and supplying the appropriate text and data. For instance, decision points in the flowchart for the Level II disc correspond to interaction icons in Authorware, and process boxes containing frame numbers correspond to video icons in Authorware.

Authoring packages such as Authorware, supply an easy way to incorporate control of laserdisc players into user-developed software. The laserdisc's remote control functions can be duplicated and integrated into software menus and control panels. Help functions can be added to provide learner support. In Authorware, once the visual elements are selected and screen layouts determined and built, the developer can easily copy these items to other locations on the program flow line as they are needed. This phase was time consuming because it mainly involved entering frame numbers into each video icon, and text onto each menu. With the coding completed, the developers tested the software by running through every pathway checking for errors. Several were found, but were relatively easy to correct. Then the laserdiscs were distributed to Consortium members.

Conclusion

The goal of this project was to make the Alberta laserdiscs available to teacher educators who have Level III videodisc players and computers. That goal was accomplished. Copies of the videodiscs were ordered from the University of Alberta, College of Education supplier, a

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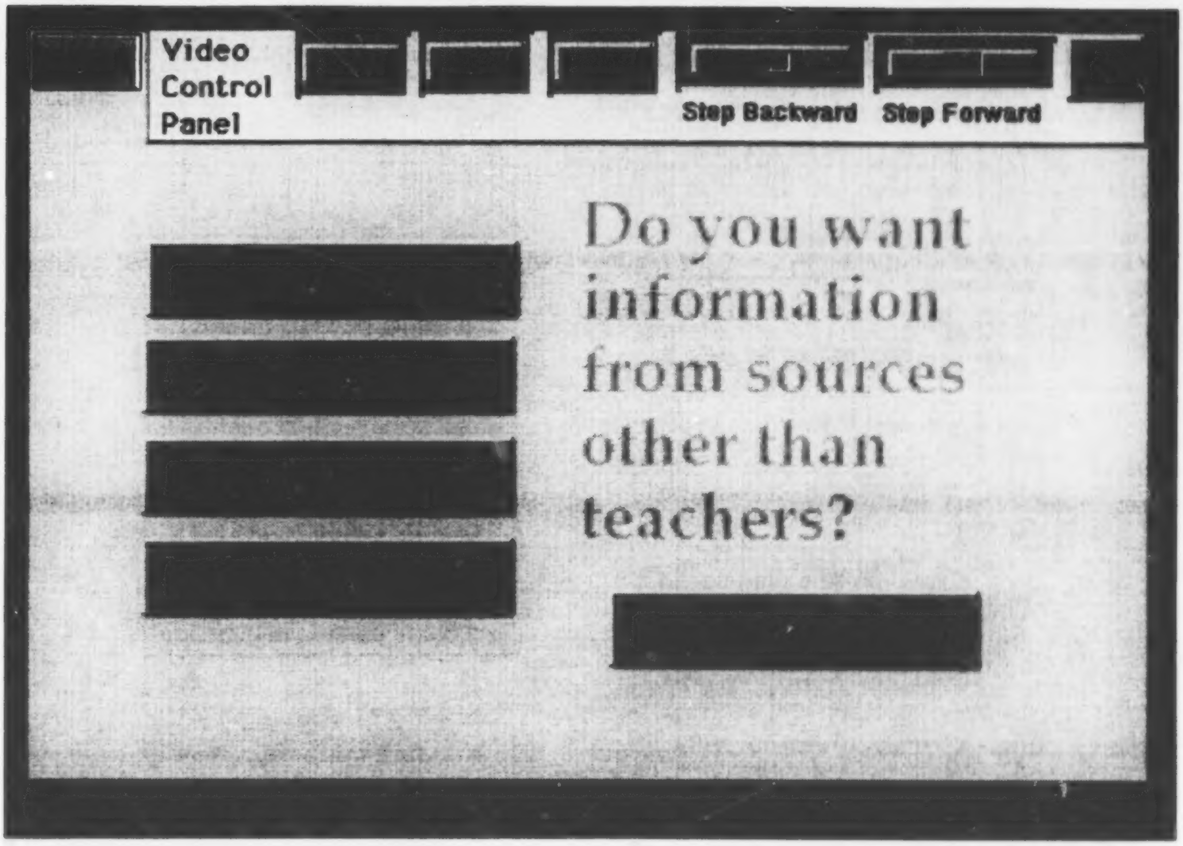

Do you want information from sources other than teachers?

Figure 2. Control Panel for "Classroom Management"

teacher's manual for the software was created, and the entire package including software was distributed to Consortim members. Other teacher educators interested in obtaining copies of the software may contact the senior author of this paper or check the CD-ROM version of this Annual.

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SIMULATION

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Over the past decade the focus of the Curry Teaching Simulation has gradually shifted from training students to use specific teaching skills (Strang, Badt, & Kauffman, 1987) to sensitizing students to more global patterns that define good teaching (Strang, 1994). During the spring of 1994 our team wrestled with a difficult problem: Should we continue researching a simulation which was yielding very productive findings, or should we redirect time and effort to start building a new simulation which would eventually allow us to extend our research to exciting new levels? Since several key research questions remained unanswered, and since we had amassed extensive data files on over 300 preservice teachers, we decided to continue the current research strand for at least one more year. Not entirely forsaking development, however, we are presently soliciting ideas from students after they complete the current simulation, and we are generating additional ideas from numerous informal brainstorming sessions. While suggestions collected so far would, themselves, yield a provocative paper, this section will concentrate on the results of three research studies, each of which explores how preservice teacher performance on the current simulation defines larger patterns which describe teacher qualities ranging from gender sensitivity to deliberation.

Research on Three Patterns

The first paper describes an initial attempt to determine whether simulation participants display gender and/or ethnic biasing as they interact with their software-defined pupils. While group statistical analyses produced little evidence of biasing, an inspection of individual teacher profiles provided several very distinct biasing patterns that warrant future investigation. Such research will be facilitated through the new simulation that will more realistically display gender and ethnic qualities of individual pupils.

The second paper explores how a trait, level of optimism, not only impacts performance on the current simulated teaching task but also relates to personal teaching expectations and beliefs. The results yielded a clear pattern defined both by the actions and the thoughts of the participants. Extreme optimists, when contrasted with moderate optimists, seem more directed by social desirability than by personal commitment. Further research on this motivational pattern might examine how extreme optimists function in actual as well as simulated classrooms and also might address other practical questions concerning such issues such as the attrition rate of extreme optimists from professional programs.

The third paper in this section describes continuing research on teaching deliberation, a teacher's ability to maintain personal control and academic direction when beset by a class of unprepared and unruly pupils. This factor, first defined by Strang and Moore (1994), was replicated in the current study. Current results also verified that taking time to think is a key definer of the deliberation pattern. Indeed, time commitment is a major variable in both the second and third papers. Whether this variable is linked to larger patterns discussed in the studies remains for future research to discover.

A Development Project

The fourth paper in this section, by Seung Jin, is quite different. It describes the creation of a new simulation that introduces teacher education students to the possibilities of the Internet. It is one of what we hope will be many computer-based simulations developed specifically for use in teacher education.

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Assessing Teaching Deliberation via a Computer-based Teaching Simulation

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Over the past decade, the Curry Teaching Simulation has helped students to prepare for both teaching and behavior-management challenges that they will later face in real classrooms (see Strang, 1993). In addition to benefitting participating students, the simulation also has served as a vehicle for exploring a variety of important research strands related to effective teaching. In recent research, Strang and Moore (1994) discovered several factors that define the techniques that preservice teachers employ as they attempt to instruct, discipline, and evaluate their software-defined pupils. Strang (1994), after having replicated the same factor structure in a group of experienced teachers, found that the two groups' factor scores differed significantly for two of the three factors. The most dramatic factor score differences suggested that during decision-making, experienced teachers deliberated more than their inexperienced counterparts. Based on factor loadings, teachers high in deliberation:

1. devote lengthy periods of time to individual events that are relevant to the lesson;
2. avoid being drawn into immediate encounters by misbehaving pupils;
3. avoid interrupting ongoing class activity to address misbehavior;
4. avoid being drawn into lengthy interaction sequences with individual pupils who have not completed their homework; and
5. avoid being drawn into new class activities without first attempting to offer feedback to a current pupil who has just rendered an answer.

The deliberation factor scores appear to reflect the degree to which a teacher is able to maintain:

- personal control,
- empathy with individual students, and
- a clear view of future lesson objectives

when beset by powerful external challenges such as unprepared and unruly pupils. The aim of this study was to define more fully the properties of the deliberation factor in preservice teachers. A two-phase study was implemented.

Exploratory Phase

The first phase of the study focused on an examination of data collected from 245 preservice teachers who had completed the simulation during the fall semesters of 1992 and 1993. A complete description of the simulation, which offers participants both teaching and behavior-management challenges, appears in Strang and Moore (1994). From the combined 1992-1993 sample, high- and low-deliberation groups were defined by subjects whose factor scores on the deliberation factor lay in the top and in the bottom quartiles, respectively. In order to identify additional variables that related to the deliberation factor, a careful review was made of several hundred measures of teacher performance that the computer recorded as each participant completed the simulation.

The results of independent t-tests applied to performance scores of the 122 subjects in the two quartile groups revealed that high deliberators differed significantly from low deliberators on the following ten variables—variables that constitute three intuitive clusters.

I. *Teaching content.* High deliberators directed more attention toward lesson-related activities and were more efficient and egalitarian in teaching their pupils than were low deliberators. As compared with their low-scoring counterparts, teachers scoring high on this five-variable pattern:

1. initiate more pupil-centered lesson events;
2. include a greater number of different pupils in lesson events;
3. include a higher ratio of prepared pupils in lesson events;
4. initiate fewer interactions as they remediate pupil content-based errors; and
5. during such remediation, provide a greater amount of textual information to the erring pupil.

II. *Intervening misbehavior.* High deliberators directly intervened pupil misbehavior less frequently than low deliberators. As compared with their low-scoring counterparts, teachers scoring high on this three-variable pattern:

6. initiate fewer direct misbehavior interventions;
7. initiate fewer requests for individual misbehaving pupils to recite rules for appropriate deportment; and
8. initiate more class requests for compliance.

III. *Rating pupil performance.* In a post-lesson rating of individual pupil initiative, academic performance, and deportment, high deliberators exhibited a response pattern that differed from that displayed by low deliberators. As compared with their low-scoring counterparts, teachers scoring high on this two-variable pattern:

9. commit more time to complete the "report card" rating; and
10. award high ratings to pupils more often.

Confirmatory phase

Since the patterns obtained in the exploratory phase could reflect the influence of Type I errors linked to the application of multiple t-tests, it was necessary to confirm the exploratory findings via a replication procedure. Subjects in this second phase of the study came from a cohort of 88 preservice teachers who completed the simulation during the fall of 1994. As in the previous phase, two groups were defined. High deliberators included those 22 participants whose deliberation factor scores lay in the top quartile; low deliberators included those 22 participants whose scores lay in the bottom quartile. Two levels of variables were analyzed. The first included the ten previously described lesson performance variables. The second, which addressed more global self-reported adaptive features, included measures obtained from questionnaire instruments which participants had completed as part of their simulation assignment. Specific variables tapped (1) personal optimism (Seligman, 1990), (2) self-monitoring (Snyder, 1987), and (3) four Keirseian-based learning styles (Golay, 1982).

Results

Factor replication. Before discussing specific variable effects, it is important to note that the 1994 cohort factor structure replicated the structure obtained from the 1992-1993 data. The coefficient of congruence for the deliberation factor was a healthy .90.

Lesson performance variable replication. Tables 1, 2, and 3 present the replication results for the ten simulation performance variables. The directions of all high- versus low-deliberator differences found in the exploratory data set were identical to those found in the confirmatory data set. The seven variables for which t-tests yielded significant deliberator group differences are marked by parentheses which enclose the appropriate significance levels for the one-tailed.

Table 1
t-test Results: Teaching Content Variables

1. Number of pupil-centered events ($p<.025$)
2. Number of different participating pupils
3. Number of events involving prepared pupils ($p<.01$)
4. Interaction count per remedial attempt ($p<.05$)
5. Amount of information provided per clue ($p<.05$)

Table 2
t-test Results: Misbehavior Intervention Variables

6. Number of direct misbehavior interventions ($p<.01$)
7. Number of rule recitation requests ($p<.025$)
8. Number of class requests for compliance

Table 3
t-test Results: Pupil Rating Variables

9. Time committed to complete post-lesson report card
10. Number of positive pupil ratings ($p<.025$)

Questionnaire data. No significant differences resulted from independent t-tests contrasting high- versus low-deliberator questionnaire scores on the personal optimism, self-monitoring, or learning style variables. The groups did differ significantly, however, on the time committed to completing the three-part questionnaire ($p<.025$). Paralleling the pattern established for teaching and behavior management, high deliberators averaged more time (21.5 minutes) to complete the questionnaire sequence than did low deliberators (14.4 minutes).

Discussion

The results of the present study help to expand the meaning of the deliberation factor's core qualities. These qualities address the degree to which a teacher, when beset by formidable classroom challenges, displays personal control, pupil empathy, and a clear view of future lesson objectives. The enhanced picture portrays the high-deliberating teacher as maintaining personal control by not being distracted by pupil misbehavior and by not being drawn into lengthy, unproductive interactions with unprepared pupils. Furthermore, the high-deliberating teacher demonstrates empathy with individual unprepared pupils by offering immediate personalized help when they err. In subjectively grading pupils, this teacher more often gives the pupil the benefit of the doubt. Finally, the high-deliberating teacher demonstrates a clear view of future lesson objectives by continually directing classroom activities toward pupil-centered lesson events and by not initiating distracting behavior-management techniques such as requesting the recitation of behavioral rules.

While the content of the questionnaire data did not contribute to a better understanding of the deliberation factor, one variable, questionnaire completion time, did. Replicating a pattern found in the two previous studies, high deliberation was strongly related to questionnaire completion time. The increased time commitment that high deliberators characteristically make to the various components of the simulation task may well depict their general reflective approach to problem solving.

Future Research Goals

The next step in expanding our understanding of the deliberation factor is to study its relationship to the existing literature base. The literature on reflective teaching was selected as an initial area for review. The first stages of this review yielded the following characteristics of reflective teachers. Reflective teachers:

- try to synchronize their teaching with the non-classroom lives of their students (Manning & Payne, 1993; Bainer & Cantrell, 1992; Sparks-Langer et al., 1990);
- constantly "fine-tune" their lesson plans even as they execute them (Bainer & Cantrell, 1992; Schon, 1983, McNair, 1979);
- believe that their teaching genuinely impacts students' lives (Colton & Sparks-Langer, 1993; Kirby, 1987);
- anticipate possible disruptions and their remediations prior to the occurrence of the disruptive events (Cleary & Groer, 1994; Manning & Payne, 1993);
- focus on maintaining smooth, flowing interactions while teaching (Ross, 1989; McNair, 1979);
- avoid the mechanical application of a set of specific techniques (Ross, 1989); and
- do not view the use of contrasting or even conflicting approaches to teaching as problematic (Ross, 1989).

Based on the literature review, a questionnaire instrument is being developed that will be included in the teaching simulation assignment that the next cohort of preservice teachers complete.

As we develop a clearer understanding of global factors such as teaching deliberation, we will hopefully be better able to:

- identify potential interaction patterns in preservice teachers that may impede their future classroom success, and
- define additional strategies for preparing preservice teachers to face their approaching classroom challenges.

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Assessing Teacher Ethnic and Gender Biases via a Teaching Simulation

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Recent literature reveals that while interacting with their students, many public school teachers exhibit behaviors that promote destructive gender and ethnic stereotypes (see Sadker & Sadker, 1994, and Murray & Clark, 1990, respectively). The current study attempted to determine whether such stereotyping occurred in a computer-based teaching environment which had been sensitive to teacher actions ranging from the deliberation that teachers use as they navigate a lesson (Strang, 1993) to the messages that they convey to their students at the close of a lesson (DeFalco, Strang, & Gordon, in press).

The Two-phase Study

A two-phase research sequence was implemented. During an initial exploratory phase, the behaviors exhibited by a sample of preservice teachers as they conducted a simulated lesson were examined in order to build three clusters of variables—clusters that presented an accurate picture of how these participants taught, disciplined, and evaluated simulated pupils that displayed both gender and ethnic differences. The teaching, disciplining and evaluating variables defined in the first phase were then analyzed in a replication study that involved a second sample of preservice teachers.

Subjects

Subjects in the exploratory phase were drawn from a pool of preservice teachers who, during the fall semester of either 1992 or 1993, participated in the Curry Teaching Simulation as part of a laboratory course requirement. A review of the ethnic and gender makeup of this 245-subject group revealed that 66.1% were Caucasian females. Since participant representation for all other clusters was exceedingly small, it was decided that these 162 Caucasian female students would constitute the first phase sample. Subjects in the replication sample included the 61 female Caucasian students in a class of 88 participants who completed the teaching simulation during the fall semester of 1994.

Simulation experience

Since the fall semester of 1992, all participants have completed a simulation exercise in which they have initiated 50 interactions with a class of 12 software-defined pupils. Pupils in this class are preset to display low levels of lesson preparation and high levels of misbehavior. Equal numbers of these pupils, through name designations, have been depicted as Hispanic females, Hispanic males, Caucasian females, and Caucasian males. The four ethnic-gender cells are equally represented by 3 distinct pupil types which include:

1. a pupil who has prepared for the lesson, is highly motivated to participate in lesson-related activities, and will not exhibit any misbehavior during the lesson;
2. a pupil who has not prepared for the lesson, is not motivated to participate in lesson-related activities, and has a high probability of exhibiting daydreaming misbehavior; and

3. a pupil who has not prepared for the lesson, is not motivated to participate in lesson-related activities, and has a high probability of exhibiting talking-out misbehavior.

Immediately following the completion of the lesson, the participant, via a computer-administered rating procedure, creates a "report card" for each pupil in which academic performance, lesson-related initiative, and self-control are estimated for each pupil.

Results

Exploratory findings

The goal of this phase of the study was to uncover the way in which participating teachers taught lesson content, managed misbehavior, and graded (1) the collective class of 12 simulated pupils, and (2) specific pupils who differed in gender and ethnic backgrounds.

1. Teaching lesson content. The teaching lesson content was composed of six variables: the number of lesson-related events, the number of different content items, the number of different answer requests, the probability that a clue would follow an error, the number of lesson-related interactions that included positive effect, and the number of interactions that included negative effect.

How did the average participant teach lesson content to the collective class? Almost 48% of teacher interactions focused on lesson-related events. During such events, the class was exposed to an average of over 41% of the items from the 32-items homework assignment. When pupils made mistakes they were provided with individually composed clues almost 48% of the time. Finally, the teacher was more likely to include positive than negative affect in lesson-related interactions.

Did pupil gender and or ethnic origin relate to participant content teaching response patterns? The results of ANOVAs applied to the six teaching lesson content variables yielded only one significant main effect: the effect for gender in the analysis of the variable that defined the teacher's use of negative affect ($F(1,161)=4.68, p<.05$). Teachers directed more negative comments to male pupils than to female pupils.

2. Managing misbehavior. Six variables defined the way in which teachers managed pupil misbehavior. Included were the number of misbehavior interventions, the probability that an initial intervention was effective, the probability that direct intervention was employed, the probability that intervention involved establishing physical proximity with the misbehaving pupil, the number of misbehavior interactions that were interrupted prior to successful resolution, and the number of times that lesson activities were interrupted to address misbehavior.

How did the average participant manage misbehavior in the collective class? Approximately 40% of teacher interactions addressed pupil misbehavior. Almost 81% of initial interventions were effective. Approximately 27% of interventions involved the teacher's specifically calling a pupil's attention to the misbehavior. Almost 33% of misbehavior interventions involved the teacher's establishing physical proximity with the misbehaving pupil. The teacher very infrequently interrupted interventions to pursue other activities and very infrequently interrupted lesson activities to address misbehavior.

Did pupil gender and or ethnic origin relate to participant misbehavior management response patterns? The results of ANOVAs applied to the six teaching lesson content variables yielded no significant main or interaction effects.

3. Evaluating pupil performance. How did the average participant evaluate pupil performance after the lesson had been completed? In post-lesson ratings of pupils' performance, teacher evaluation accuracy averaged 61%, 53%, and 70% for pupil initiative, academic performance, and self-control, respectively. There were two types of rating errors: Commission errors were defined by inaccurate estimates, and omission errors were defined by failures to estimate. Teacher commission errors for pupil initiative, academic achievement, and self-control averaged 20%, 33%, and 24%, respectively. The less frequent omission errors averaged 19%, 14%, and 5%, respectively.

Did pupil gender and or ethnicity relate to participant evaluation patterns? Compared to the teaching lesson content and managing misbehavior variables, ANOVA analyses applied to the six pupil rating variables yielded a stronger pattern of pupil gender and ethnic origin effects. Specifically, one gender and one interaction effect emerged.

- There was a gender effect for the commission error initiative rating variable ($F(1,161)=5.39, p<.05$). Teachers were more likely to rate inaccurately the initiative of male pupils than the initiative of female pupils.
- One gender by ethnic origin interaction effect was found for the inaccurate self-control rating variable ($F(1,161)=9.92, p<.01$). An inspection of cell means revealed that teachers were particularly prone to rate inaccurately the self-control displayed by the three Hispanic male pupils.

Confirmatory findings

The second phase of the study addressed the replication of exploratory-phase results. An attempt was made to ascertain whether the general patterns of teacher behavior found in subjects included in the exploratory phase were replicated. Simple descriptive statistical tools were employed to achieve this goal. Next, an attempt was made to replicate the significant pupil gender-ethnicity effects found in the exploratory phase. The three variables, negative teacher comments, inaccurate initiative ratings, and inaccurate self-control ratings were submitted to the same 2 X 2 repeated measures ANOVA analyses that had been employed in the exploratory phase.

The general behavioral patterns displayed by teachers in the 1994 cohort on the three dimensions essentially replicated those shown by the 1992-1993 cohort. Tables 1, 2, and 3 present means and standard deviations (within parentheses) for the 18 variables constituting the three dimensions

Table 1
Teaching Lesson Content

Variable	Phase 1	Phase 2
Number of lesson-related events	23.78 (5.97)	23.33 (5.88)
Number of different content items	13.14 (3.88)	13.00 (3.87)
Number of different answer requests	17.38 (7.29)	16.00 (7.19)
Probability that clue would follow a pupil error	.48 (.25)	.52 (.20)
Number of lesson-related interactions that include positive effect	14.04 (6.84)	14.21 (5.98)
Number of lesson-related interactions that include negative effect	.40 (.77)	.49 (.72)

Table 2
Managing Misbehavior

Variable	Phase 1	Phase 2
Number of misbehavior interactions	20.20 (3.88)	20.74 (4.57)
Probability of effective 1st intervention	.81 (.14)	.78 (.13)
Probability direct intervention was used	.27 (.15)	.30 (.17)
Probability misbehavior intervention involved physical proximity	.33 (.15)	.27 (.13)
Number of misbehavior interventions that were interrupted	1.09 (1.67)	1.28 (1.52)
Number of lesson activities that were interrupted to address misbehavior	.83 (1.20)	.49 (.74)

Table 3
Evaluating Pupil Performance

Variable	Phase 1	Phase 2
% of initiative evaluation errors that involved commission	19.91 (18.35)	19.40 (17.46)
% of initiative evaluation errors that involved omission	19.39 (28.35)	20.90 (29.45)
% of academic evaluation errors that involved commission	32.77 (17.97)	29.51 (16.00)
% of academic evaluation errors that involved omission	14.04 (19.14)	15.57 (20.66)
% of self-control evaluation errors that involved commission	24.38 (14.13)	24.59 (11.73)
% of self-control evaluation errors that involved omission	5.35 (9.27)	5.60 (9.94)

Attempts to replicate the three gender-ethnicity effects found in the exploratory phase failed. No main effect for gender on the negative teacher comment was found (F(1,60)=.61); no main effect for gender on the inaccurate initiative ratings variable was found (F(1,60)=.14); nor was a gender by ethnic background interaction found on the inaccurate self-control rating variable (F(1,60)=1.62). Even inspection of the cell mean patterns across the years offered little support for replication effects.

Discussion

Overall, the preservice teachers in both cohorts demonstrated effective teaching when challenged by a class of poorly prepared pupils who were prone to misbehave. Little evidence of gender or ethnic biasing was found: In the preliminary phase, ANOVAs applied to 18 dependent variables yielded only 3 significant effects, effects that did not replicate in the second phase. An inspection of individual participants' performance records suggested that a small number of the preservice teachers did exhibit a variety of distinct biasing response patterns. For example, one teacher was more than twice as likely to involve Hispanic pupils in lesson-related events and more than twice as likely to award positive grades to Hispanic pupils. Another teacher showed a similar biasing pattern that favored Caucasian pupils. One of the most widespread patterns was displayed by 13 participants. Even though male and female pupils were preset to initiate similar misbehavior patterns, these teachers, apparently identifying with the "bad boy" stereotype, offered at least twice as much misbehavior intervention to male pupils and were at least twice as likely to award positive ratings to female pupils.

Three considerations impact the use of the simulation in future research on teacher biasing. First, the variations in biasing patterns that individual teachers displayed in the current study suggest that data obtained from future studies should be submitted to cluster analysis. Second, pupil representation must be improved. Each pupil in the current simulation was portrayed by crude monochrome graphics beneath which a name defined gender and ethnic features. An anticipated "new" simulation will more realistically define the gender and ethnic characteristics of pupils via photo-like visual representations. Additional vocal pupil response clips may also be added. Third, recall that the current study included only Caucasian female participants. Future research needs to explore whether teacher ethnicity and gender relate to pupil biasing patterns.

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From Trait Optimism to Simulated Teaching Experience

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For the past decade, the Curry Teaching Simulation has provided preservice teachers with real-time experience in conducting academic lessons and controlling classroom misbehaviors. Two major benefits have resulted. First, preservice teachers have gained experience in working with pupils who have offered a variety of challenges. Second, the simulation has provided a means for studying a variety of practical research questions pertaining to the education of teachers. A recent strand has explored how individual participants' simulated teaching performance reflects teaching styles, personalities, and belief systems (Strang & Moore, 1994; Strang & Mazulewicz, 1995). In focusing on the unique messages that teachers use to close their lessons, DeFalco, Strang, and Gordon (in press), found that many preservice teachers attempt to maintain a positive tone under very challenging conditions. As a result, they give their pupils inaccurate information about their behavioral and academic performances.

Weinstein (1988) has researched this "unrealistic optimism" construct in a broader context. She found that many messages that society and teacher-education programs, themselves, convey to preservice teachers encourage unrealistic optimism. Such messages include the notion that teaching is instinctive and that the teacher should do what "feels right." Another message is that warm, positive personality traits predict successful teaching.

Martin Seligman (1991) has also researched optimism. He developed a short inventory for assessing learned optimism, a personality dimension which is designed to measure the ways in which people perceive positive and negative events in their lives. According to Seligman, individuals high in optimism tend to view positive events as permanent and pervasive, and negative events as temporary and situational.

The purpose of this study was to determine whether preservice teachers' levels of optimism, as measured by Seligman's scale, related to their performance on three different tasks. The tasks, which tapped teaching behaviors, teaching beliefs, and personality traits, included:

- the simulation teaching assignment;
- an instrument designed to assess teaching expectations and perceptions; and
- a personality inventory that measured self-monitoring.

Implementation

Two groups of preservice teachers participated in the Curry Teaching Simulation as part of a laboratory course requirement in the fall of 1993 and the fall of 1994. These groups consisted of 112 and 88 subjects, respectively. The simulation experience involved a set of realistic challenges in which participants, assuming the role of teachers in a class of software-defined pupils, reviewed math and spelling exercises for an upcoming test. The pupils varied across levels of initiative, preparedness, and propensity to misbehave. Overall, the class provided challenges for the teacher: Little class time was free of misbehavior and teacher-solicited homework responses were predominantly inaccurate. Teachers interacted with their pupils via two forms of keyboard input. The first consisted of selecting menu options; the second consisted of constructing text statements. The text statements could be used to introduce the lesson, to provide clues to an erring pupil, and to conclude the lesson.

Prior to beginning the simulation exercise, all participants completed Seligman's optimism inventory (1988, pp. 33-39). Teachers in the fall 1994 cohort also responded to two additional questionnaires. The first, Weinstein (1988), was designed to measure beliefs and expectations about teaching. The second, Snyder (1987, pp. 18-19), was designed to assess the degree of self-monitoring--the degree to which an individual is sensitive to social cues.

The study consisted of two phases. In the first phase, scores on the optimism scale were reviewed. Two large groupings of scores emerged. The first group, consisting of 26% of the preservice teachers, earned extreme optimism scores; the second group, consisting of 42% of the teachers, earned moderate optimism scores. Once the groups had been defined, clusters of simulation performance variables were reviewed to isolate response patterns. The second phase centered on the performance of the 1994 cohort. Attempts were made to validate behavioral patterns established in the first phase through an analysis of questionnaire data that defined more global patterns of expectations and personality traits.

Initial Results

A series of 2-way analyses of variance (Optimism Level X Cohort) revealed simulation level main effects for five key variables. The resulting pattern revealed that extreme optimists differ significantly from moderate optimists in six ways. Extreme optimists try to involve as many pupils as possible in lesson activity, but, in interacting with individual pupils, they:

- communicate clues more quickly;
- use fewer words in the clues that they provide; and
- use stereotypic and direct techniques to intervene misbehavior.

Extreme optimists also:

- spend less time introducing and concluding the lesson and
- spend less time rating their pupils.

This pattern clearly suggests that extreme optimists conduct their classes in a superficial and socially desirable manner. They seem more concerned with the number of different pupils included in the lesson than with the quality of individual pupil interactions. In a similar vein, they devote little effort to framing personalized lesson introductions and conclusions. Finally, they demonstrate the same pattern as they grade their pupils.

Validating Results

The results obtained in the first phase of the study could reflect the influence of Type I errors linked to the multiple analyses. In lieu of a direct replication, an attempt was made to systematically replicate the phase I results by comparing optimism levels of the 1994 cohort with several new measures of global beliefs, expectations, and attitudes. This approach was implemented via a series of simple t-tests. Dependent variables were obtained from two instruments. The first instrument, a questionnaire developed by Weinstein (1988), provided 12 measures that tapped preservice teachers':

1. expectations about future occupational performance;
2. beliefs about the personal qualities of a "good teacher"; and
3. beliefs about their own personal qualities.

The second instrument, a questionnaire developed by Snyder (1987, pp. 18-19), provided a single measure that assessed individuals' self-monitoring.

Beliefs and Expectations about Teaching Questionnaire

Tables 1, 2, and 3 present the results of 12 t-tests which contrast extreme versus moderate optimism levels across the variables derived from the Weinstein instrument.

Table 1.
Part 1: Expectations

Variable	First-year teaching performance		
Means	Extreme Optimists	Moderate Optimists	One-tail prob.
	5.43	5.44	.48
Variable	Instruction performance		
Means	Extreme Optimists	Moderate Optimists	One-tail prob.
	5.71	5.22	.06
Variable	Organization and management skills		
Means	Extreme Optimists	Moderate Optimists	One-tail prob.
	5.43	5.06	.16
Variable	Ability to get along with others		
Means	Extreme Optimists	Moderate Optimists	One-tail prob.
	6.29	5.61	.01

Table 2.
Part 2: Beliefs about what makes a "good teacher"

Variable	Ability to be humorous		
Means	Extreme Optimists	Moderate Optimists	One-tail prob.
	3.29	3.95	.08
Variable	Ability to relate to people of different backgrounds		
Means	Extreme Optimists	Moderate Optimists	One-tail prob.
	3.86	3.89	.38
Variable	Degree of warmth		
Means	Extreme Optimists	Moderate Optimists	One-tail prob.
	3.86	3.58	.05
Variable	Level of outgoingness		
Means	Extreme Optimists	Moderate Optimists	One-tail prob.
	3.29	3.32	.46

Table 3.
Part 3: Teacher beliefs about themselves

Variable	Ability to be humorous		
Means	Extreme Optimists	Moderate Optimists	One-tail prob.
	2.29	2.47	.20
Variable	Ability to relate to people of different backgrounds		
Means	Extreme Optimists	Moderate Optimists	One-tail prob.
	2.50	2.63	.26
Variable	Degree of warmth		
Means	Extreme Optimists	Moderate Optimists	One-tail prob.
	2.79	2.79	.49
Variable	Level of outgoingness		
Means	Extreme Optimists	Moderate Optimists	One-tail prob.
	2.71	2.42	.22

The results from the teacher expectation and belief questionnaire revealed that extreme optimists differed significantly from moderate optimists in two ways. In Part 1, on attitudes about future teaching achievement, extreme optimists perceived they would get along better with others than did moderate optimists. In Part 2, which addressed beliefs about "good teacher" characteristics, extreme optimists perceived warmth as a more essential characteristic than did moderate optimists. In Part 3, which addressed beliefs about their own personal characteristics, extreme optimists did not differ significantly from moderates.

Self-Monitoring Questionnaire

Table 4 presents the results of a t-test contrasting extreme versus moderate optimism levels across the variable derived from the Snyder instrument.

Table 4.
Self-Monitoring Questionnaire

Means	Extreme Optimists	Moderate Optimists	One-tail Prob.
	12.95	11.59	.03

Extreme optimists scored significantly higher on self-monitoring. Such scoring indicates a pattern characterized by a sensitivity to the social environment, a proclivity to adjust to situational demands, and a need to create a favorable impression on others.

Discussion

Previous research suggests that many preservice teachers may be unrealistically optimistic about how well they will function in their future teaching roles. The results of this study confirm the existence of this optimism trait in a cohort of preservice teachers. Beyond this confirmation, the results help us to further understand the ways in which personality variables can affect teaching performance.

Extreme optimists appeared to navigate the simulation very differently from moderate optimists. While they seemed to "do a good job" by interacting with as many pupils as possible, a close inspection reveals that their interactions were very superficial. At a deeper level, the extreme optimists, when compared with moderate optimists, seemed to exert less effort in completing activities such as introducing the lesson, assisting erring pupils, closing the lesson, and in evaluating pupils. It appears that extreme optimists wanted to give a good impression of their teaching but did not want to commit much time or mental effort.

The questionnaire validation phase of this study provided additional global information regarding the character of the extreme optimists. Results confirmed that extreme optimists appear to be more susceptible than moderate optimists to adopting the belief systems which society and teacher-education programs often promote. Identifying with societal values, extreme optimists were more likely to perceive good teachers as individuals who exhibit a high degree of warmth. Extreme optimists were more likely to expect that they would become teachers who would get along with others. Further clarifying the pattern, the self-monitoring results portrayed extreme optimists as more socially attuned and more willing to adjust to external conditions than moderate optimists.

The attitude-belief pattern displayed by extreme optimists in phase II replicates the behavioral pattern displayed by extreme optimists in phase I. Both in action and in thought, extreme optimists' approach to teaching seems to be more influenced by social desirability than by thoughtfulness and personal commitment.

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INSTRUCTIONAL DESIGN

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Technology continues to develop at an accelerated rate, bringing new opportunities for teacher educators to share with their students what could hardly be imagined even a few years ago. Thus, the successful classroom of tomorrow bears little resemblance to the classroom of today and what the teacher educator needs to know about educational technology is very different from what was required in the past. Becoming proficient with the new computer-based technology would be simple if it were just a matter of keeping abreast of the literature or using it for personal productivity. However, teacher education students will not be encouraged to implement technology into their classrooms of tomorrow unless the necessary skills and strategies are modeled in the educational courses of today.

Technology affords teacher educators the opportunity to make sweeping changes in education by modeling how to incorporate information technology into the preparation of teachers. Computer-based technology is making it less defensible to put 25 or so students in a classroom and attempt to teach them the same thing for the same length of time. However, technology is not a panacea that will cure what ails teacher education but rather a reality in the daily lives of these teacher education students if they are to become full participants in an increasingly interconnected global information environment. The focus of the papers in this section is one the role instructional design in this challenge.

Cafolla and Knee discuss some of the factors that hamper the integration of technology in teacher education. They explain the common problems which hamper appropriate integration of technology in the schools as well as teacher education programs including the lack of adequate teacher training, insufficient funding, the resistance of teachers to change, and inappropriate or antiquated hardware and software. A very interesting aspect of this article is the role of modeling on curricular integration. Teacher educators must design their courses and supervised experiences so that they act as coaches who model appropriate uses of technology in the classroom. The aspect of curricular integration can also be found in the discussion of Craig concerning multimedia. This discussion lays the foundation of multimedia in computer-based training. Mackie and Corbly concur that computer-based multimedia aids in the learning process. They argue that learning to use interactive multimedia is within the grasp of anyone regardless of their computer expertise. Furthermore, the use of multimedia can increase the confidence of the most neophyte user. Valmont and Blanco join this discussion with examples of how multimedia can present potent teacher-centered lessons as effective models in teacher education courses. They also present other technology projects to illustrate technology use within the classroom.

Pan and Lee look at computer use by K-12 teacher. They discuss the resistance to learning new technologies among teachers who considered themselves technology proficient because they had been performing simple word processing tasks. This study and the resultant model developed for training is an excellent example of why

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training teachers who know how to use older established information technology is still necessary. The final paper in this section, by Chen and Willis, describes in some detail the process of creating an electronic book - the CD-ROM version of the Annual.

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Factors Limiting Technology Integration in Education: The Leadership Gap

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While there is little doubt that technology in education can play an important role is restructuring teaching and learning (Fuson & Brinko, 1985; Goldman, Pellegrino & Mertz, 1987), there is a strong feeling of disappointment and disillusionment among teachers regarding the integration of technology in education (Marcinkiewicz, 1991). This paper discusses some of the factors that have hampered the integration of technology in education. In order to establish a theoretical framework to define the concept of computer integration, the first section of this paper discusses the Welliver's (1989) instructional transformation model. The paper then discusses the factors that have inhibited the integration of technology including lack of adequate teacher training, insufficient funding, resistance to change, and inappropriate hardware and software. Finally we discuss the effects of leadership, particularly modeling, on integration.

Instructional Transformation Model

Welliver's (1990) instructional transformation model describes five hierarchical stages which reflect the level of technology integration. During the first stage, *familiarization*, the teacher becomes aware of the computer, it's capabilities, limitations and the variety of potential applications to education. In the second stage, *utilization*, the computer is used as an adjunct to classroom teaching or administration. The use of the computer is peripheral and auxiliary. During this stage, the slightest complication can cause the use of technology to be discontinued. During the third, or *integration* stage, the computer is integrated to the point that the educational processes cannot fully continue without computers.

In the fourth stage of instructional transformation, the *reorientation* stage, there is a re-thinking of the relationship between the educational goals of the institution and technology. Planning now includes an analysis of both human and technological resources. The final stage, *evolution*, is more a hope for the future than an actual stage. During this stages educators will evolve in their sophistication in the integration of technology into the educational process. Welliver suggests that this evolution should follow a systematic process for maximum effectiveness.

How does one transform an instructional program and carry it through the integration, reorientation and evolution stages? While there may be many approaches, it seems apparent that there will be important common elements. Perhaps the most significant element is the need to shift attention to what the teacher does during the daily instructional process to the needs of the learner and how those needs can best be addressed (Welliver 1990). In other words, the priority must be placed on devising ways in which human and technological resources can be focused on the ultimate goals of the educational institution.

Factors Inhibiting Integration of Technology

This section describes several factors that the literature suggests are responsible for the limited integration of technology in education. These factors include inadequate teacher training, insufficient funding, inappropriate and limited hardware and software, education's resistance to change, and leadership.

Inadequate Teacher Training

Many researchers have suggested that the lack of high quality teacher training is a major factor impeding the integration of technology in education (Kearsley & Lynch, 1994; Shermis, 1990; Stoddart & Niederhauser, 1993). In fact, a survey of teachers who use computers found that most of them rated "self-training" as the major factor that contributed to their expertise. Graduate courses in educational technology were rated near the bottom (Vockell, Jancich & Sweeney, 1994).

The nature of teacher training programs has evolved dramatically over the last ten years. A decade ago, it was necessary to spend a good deal of time on highly technical issues like formatting disks, copying files, and other operating system intricacies not directly related to educational uses. The rote nature of these operations both turned off many teachers and left little time for pedagogical issues. As Willis (1994) correctly points out, the widespread adoption of easy to use Windows and Macintosh platforms has resulted in less need for technical training. This should provide more time to consider more important aspects of teacher training.

One of the most important aspects of teacher training consistently cited in the literature relates to the motivational level of the teacher. Sheingold and Hadley (1990) note that highly motivated teachers are more likely to integrate technology. Because self competence is an important aspect motivation (Marcinkiewicz, 1991), effective teacher training must make teachers feel competent with the computers (Harvey, 1990).

It also seems clear that initial teacher training is not sufficient. Educators must be given follow up assistance for professional development including peer coaching and department level planning (Sterns, 1991).

Insufficient funding

There is little doubt that the lack of adequate funding has affected computer integration (Kearsley, 1994). Clearly, if lack of funds results in limited computer access, technology integration cannot succeed (Sterns, 1991). However, there are other factors to be considered.

For example, there is the question of how the available funds are spent. Currently, many educational institutions have spent the majority of resources to the acquisition of computer hardware and software (Stoddart & Neiderhauser, 1993). It is not clear that, in the absence of teacher training and other support, the mere acquisition of computer equipment leads to integration. In fact, there are some indications that this is not the case.

In a national survey, Sheingold, K., & Hadley, M (1990) show that even in schools where there were more than twice the number of computers per school as the national average, only about one teacher per school had integrated the computer into the classroom. It should be noted that in this survey, the average school had only 26 computers. The "exemplar" schools only had about 59 computers per school. One is left to wonder how well pencils would be integrated into education if there were only 60 available per school! It may be that schools are so far from reaching a critical mass of technology that integration is not yet possible. The first teacher that becomes the building "expert" monopolizes the computers and other teachers are too intimidated to do more than just watch.

On the other hand, when Vockell, Jancich, & Sweeney (1994) compared two school systems, one having 2.2 computer per class and the second having nine, they found that the first system did a significantly better job of integrating technology. From these studies, it seems reasonable to conclude that while adequate funding for computer hardware is necessary for integration, it is not sufficient to ensure it.

Inappropriate hardware and software

While it is true that selecting appropriate computer hardware and software is important, the simple fact is that selecting them is not as difficult as it was a decade ago. While true affectionados argue passionately for their favorite platforms, both current computers (Windows-based and Macintosh) are appropriate for use in education. Both machine types run similar, and in most cases identical, software. Unlike the days of the TRS-80, Apple II, Atari, and Commodore 64, it is difficult to purchase the "wrong" computer. Of course, we recognize that many schools are still using some of the antiques mentioned above.

It must also be recognized that as computers become more integrated, reliability of equipment becomes more critical. Breakdowns, once just an inconvenience, becomes disruptive in the educational process (Sterns, 1991).

Resistance to change

Kearsley (1994) points out that there is a degree of overt resistance to computer technology on the part of educators. Making educators more willing to change is a key factor in fostering computer integration (Marcinkiewicz, 1993). Since the educational establishment is conservative in nature (Postman, 1979), new approaches tend to be assimilated into the status quo. For example, Stoddart & Niederhauser (1993) note that despite new cognitive approaches to learning like constructivism, education is still bogged down in the behavioral paradigm of the 1960's. Despite spending more than 2.7 billion dollars on computer hardware and software (Software Publishers, 1992), the school curriculum is still dominated by lecture, texts, and other forms of passive learning (Kromhout & Butzin, 1993). It may be that schools will have to be restructured in order to fully integrate technology (Fullan, 1990).

It should also be noted that this resistance to change is somewhat offset by the tremendous support that computer technology has from the government, academia, and general public. These groups generally share the view that computer technology has the potential to have a major positive impact on education (Marcinkiewicz, 1993).

Providing adequate teacher training, selecting appropriate hardware and software, and overcoming resistance to change are clearly the role of educational leaders. The balance of this paper discusses the effects of leadership on integration with an emphasis on the leader as a role model.

The Effects of Leadership on Integration

While in the early days, the computer revolution was a bottom-up phenomenon, effective leadership is needed to ensure the long term success of technology (Becker, 1993; Finkle, 1990). The concept of leadership covers the gamut of behaviors and ideologies from meticulous management and adept political maneuvering to the facilitation of others' activities by the leadership's words of direction or example (Dede, 1992).

This section discusses the major thrust of leadership in the field of instructional technology; the reformation, indeed the transformation, of our educational system to take advantage of the potential of the new instructional technologies (Rieber & Welliver, 1989).

Commitment and Support

Experts agree that supportive leadership is necessary for integrating technology in the schools. It is not an exaggeration to say that the success or failure of the integration process rests on the shoulders of leaders, supervisors and trainers (Salzano, 1992).

In a survey of teacher educators in the United Kingdom, 81% reported that "more commitment from management" was very important. Only 38% felt as strongly about "more hardware and software" (Schram, 1994). Willis (1994) notes that this involvement, or buy-in, and ongoing support of building-level and district-level administrators is a critical component of integrating technology.

Educational leaders must view the current situation regarding effective integration of technology with some degree of despair. They must look at their own leadership style asking the tough question. "What must I do?" It is our belief that the leader must act as a role model. The leader must have a clear vision of the possibilities that technology will provide for education and must act upon this vision. The leader must be a role model of a computer using educators. Only then will teachers really believe in technology. It is difficult to imagine a leader who does not use technology trying to convince teachers that it is important.

The Leader as Role Model

There has been little critical research of technology leadership and the factors associated with the exemplary use of technology (Kearsley and Lynch, 1992). There should be no doubt that technology leadership is inherently linked to innovation. The need for training in teacher and leadership preparation is overwhelming for actually making technological innovation a reality in our schools.

In spite of the agreement that technology usage and an understanding of the educational uses of technology is required by school leaders (Bozeman, Rauchert, & Spuck, 1991), few administrators at any level have received any formal preparation for instructional technology. Most have learned what they know on their own. Kearsly and Lynch (1992) report that most administrators depend completely on teachers or technology specialists and in many cases vendors for guidance. "Educational technology leaders need to be able to use technology to solve real problems in schools." Several studies support this notion.

Thomas and Knezk (1991) examined restructured schools and consistently identified training for administrator preparation as an overwhelming need for actually making technological innovation a reality in our schools. It takes a skilled educational leader to bring about successful technological innovation.

In a case study of three schools that had been identified as successful integrators of technology, Wilburg (1991) found that in all three cases, the administrator was a strong advocate and user of computer technology. This seems to support the notion that administrative modeling may be one key to integrating technology.

In a study of two schools with equal computer access undergoing technology innovation, significance was found between the way the two schools use technology and the student outcomes. This significance was attributed to the leadership and management abilities of the two principals of the schools. It was concluded that it takes a skilled educational leader to bring about successful technological innovation. "The principal must understand how to operate and manage the new technology" (Levinson, Doyle & Benjamin, 1993).

In their 1987 book, *The Leadership Challenge*, James Kouzes and Barry Posner identified five leadership traits common to successful leaders. They note that successful leaders challenged the process, inspired a shared vision, enabled others to act, modeled the way, and encouraged the heart.

If leaders are to direct the course of action towards technology integration, they must engage in the most demanding of the leadership tasks, is modeling the way. "Your job gives you authority. Your behavior earns you respect" notes Federman (1983). In the extensive research cited by Kouzes and Posner (1987), 95% of the successful leaders reported that they modeled the way through planning and leading by example. "I began by becoming a role model that exemplifies the organizational and management values I believe are important." (Kouzes & Posner, 1987). Leaders will act in ways that are consistent with their beliefs. In other words they will "practice what they preach."

Kouzes and Posner's (1987) research shows that effective leadership is observable and has a learnable set of practices. Their data, based on the Leadership Practices Inventory, shows that modeling is one of these observable practices.

Modeling is the way that leaders make their visions tangible. In order to set an example, leaders must know their values and live them. If we truly value the place of technology in the educational process then that value becomes our "bottom line." Values constitute our personal "bottom line" and leaders must model their values to those they would lead. The administrator or teacher that does not use electronic messaging as a fundamental part of their daily life is by their actions modeling its value in their domain.

"We must practice what we preach," argues Harvard professor Chris Argyris (1977). He refers to this challenge as the difference between "espoused values" (professing the value of using technology) and "values-in-use," (modeling the value of using technology). This is the difference between the values that we say and believe that we use and those that we actually use. It is important to remember that style is not how leaders think they behave in a situation but how others (most importantly, their followers) perceive their behavior (Hersey & Blanchard, 1988).

The message is clear. If true integration of technology is to occur in the educational process we must have leaders that "model the way." To be effective, leaders must act as coaches. They show others how to behave. They demonstrate what is important by their actions. By observing what their leader does, teachers can see what is expected and required of them. Visibility is another technique for making intangible values tangible and concrete (Kouzes & Posner, 1987).

Conclusion

There is little doubt that the educational establishment is a long way from integrating technology at anywhere near it's potential. While we agree that better teacher training, inadequate funding, inappropriate hardware and software, and resistance to change are all important factors inhibiting integration, we propose that the leadership gap must also be considered. We believe that the successful leader will be a strong advocate and user of technology, and only by modeling computer use will the leader be able to convince teachers of the importance of technology.

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Learning Criteria for Multimedia Lessons

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As educational reform sweeps across America, teacher education is challenged to identify and meet the varied needs of a dynamic student population. A significant part of educational change is the expanded use of instructional technology. This trend brings problems and promises into the classroom for K-12 teachers.

Instructor's Dilemma

During recent years, the author has received numerous complaints about commercially developed computer based training (CBT) courseware. The complaints include the lack of clear objectives, directions and interactivity and too much entertainment in the form of animation and sound. As a result, instructors are asking, "How can I develop my own CBT lessons?"

Definitions

Multimedia may be defined as a group presentation or self-paced individualized lesson which combines text, graphics, sound, video and animation in order to communicate a message from one place to another or from instructor to student(s). The simplest example of multimedia would be a sound/2x2 slide presentation using an audio tape player and slide projector. A more complex example might be a computer generating different questioning levels in a video format from a compact disc.

A related term, CBT may be defined as a form of instruction whereby a preplanned, computer driven lesson organizes and creates situations in which the learner interacts with the content to be learned in order to achieve a goal. As used in this article, multimedia is the broader term and CBT is more specific.

Advantages

There are many benefits of using well developed CBT multimedia in instruction (Miller, 1990).

1. Reduced learning time - studies show an average of 50 percent time saved;
2. Reduced cost - cost (mainly in the design and production phase) is reduced as more students use the same program;
3. Instructional consistency - instruction is delivered the same at any place, time and to any audience;
4. More privacy - one to one instructional systems allow participants to trial and error, fail tests and ask embarrassing questions without disclosure;
5. Mastery of learning - instruction progresses as mastery is achieved;
6. Increased retention - several studies show significant retention of content over time;
7. Better safety - students can explore and experiment with potentially dangerous subjects and situations without risk;
8. Increased motivation - all studies show that interaction produces feedback, multisensory involvement and greater enjoyment of learning;
9. Multiple access - participants can use programs when they need and want them and at a variety of places;

10. Increased involvement - as more senses and activity are required of the student, more learning and progress occurs.

This brief review of some of the instructional advantages of using multimedia in teaching implies learning criteria for CBT lessons. The criteria are: interactivity, trial and error with feedback, multisensory learning experiences and self-pacing.

Development/Production

A model has been developed that provides useful guidelines for developing and producing computer based lessons (Alessi and Trollip, 1991). To design and produce a CBT lesson, an instructor should perform the following steps:

1. Determine needs and goals. One must analyze the needs, abilities, interests and past experiences of the learners. Then the instructor should identify specific instructional objectives.
2. Collect resources. This step involves a process of locating and securing content, people and funds. Also important is the selection of the computer itself, word processing packaging, authoring program and peripheral hardware.
3. Learn the content. It may seem trite to tell an instructor to learn your content. However, it should be remembered that shallow understanding produces shallow lessons.
4. Generate ideas. This step requires creativity and may involve a variety of people. One of the best ways to generate ideas is to use the brainstorming technique.
5. Design the instruction. At this point the actual subject matter expert and instructional designer must review the generated ideas and select the best ones for this lesson.
6. Flowchart the lesson. A flowchart is a series of diagrams describing the operations a computer performs when presenting the lesson. It indicates when the computer will go forward, branch, backup or stop, how the student will interact with the lesson and what to do if the student makes a mistake.
7. Storyboard the lesson. Storyboarding is the process of sequencing the visual and audio messages and content of the total lesson. One storyboard form involves the use of 3x5 cards, one for each planned computer frame. The card includes a title, name or sequential number, a 2x2 box in which to diagram a visual, some audio and/or graphic production notes and a brief script.
8. Author the lesson. This process involves translating the storyboard frames into a series of instructions understandable to the computer. Selected authoring software include such names as CourseBuilder, Supercard, Multimedia Toolbook, Ultimedia Builder/2, and Director. Authoring software should be easy to learn and user friendly.
9. Prepare supporting materials. Most computer based lessons are not totally self-supporting. There may be need for student, instructor or technical manuals and worksheets, check lists, assignment sheets and tests.
10. Evaluate and revise. As mentioned above, all of the persons involved in developing and producing the lesson should be involved in critiquing the final computer lesson product.

Although the above process appears lengthy and complex, the author has used it successfully with graduate students who are K-12 teachers and trainers in business and industry. Typically, a fifteen minute CBT lesson will take from 100 to 500 hours to develop and produce.

One of the implications of the development/production process for learning criteria is the control that the instructor has over the CBT lesson. The teacher can make lessons that match the student needs, fit the curriculum objectives, provide frequent interaction and feedback and complement the assessment policies of the school.

Learning Principles and the Multimedia Lesson

In some respects, the development and production steps described above could serve as criteria for judging the value of a computer lesson. However, instructors and users want to know, "Does this lesson really teach?" Hence the need to identify and describe learning principles that will assist instructors to develop/produce and/or buy computer lessons that produce desirable changes in student behavior.

Although much is yet to be discovered about teaching and learning, there are a number of teaching functions that can serve as standards for effective instruction (Rosenshine, 1986).

1. The lesson *expectations* should be presented early in the learning experience and in a clear and simple manner. Expectations are the mental and physical demands or requirements communicated to students as standards of achievement.
2. *Motivation* of the learner should occur throughout the lesson. All learning is purposeful, therefore students need a motive to learn.
3. Learning is meaningful only if it fits into a known *context* or past experience. New learning must be hooked into something real in the experience of the learners.
4. The *content* to be learned must be current, relevant, accurate and authoritative. The credibility of the content is critical for all learners, especially those who are older with considerable work experience.
5. How the content is *presented* is one of the largest variables affecting learning efficiency. Among the suggestions for effective presentations include: using logical organization of content, using more graphics than text and using a variety of methods during the presentation.
6. Instruction that is *clear* means giving directions and explanations that can be understood by the learner. Hence the words and sentences used must match the comprehension level of the learners.

7. *Pacing* involves how rapidly the student may progress through the lesson. The pace of instruction should be controlled by the instructional designer, i.e., the learner must become involved with each screen before going on to the next.
8. Learning efficiency increases when the content is broken down into *small steps.* The more complex the content, the smaller should be the steps.
9. *Practice* is one of the more important steps in learning because it is when the learner becomes directly involved with the content.
10. *Review* includes the important principle of repetition, i.e., what is repeated is learned. Review should occur throughout a lesson, not just at the end.
11. *Assessment* is another essential step in the instructional process. Assessment helps to determine how much the computer lesson has taught and how much the learner has learned.
12. Most learners have the common need of wanting to know, "How am I doing?", therefore instructors have the responsibility to provide frequent and immediate *feedback* to learner responses.
13. Although *interaction* relates to several principles above, it correlates very highly with instruction. Computer lessons that are very interactive cause a high degree of learning among the students.

Each of these learning principles can provide one or more criterion that can be used to evaluate the effectiveness of a CBT lesson. The principles can be applied to commercial or instructor developed lessons.

Silver Lining

Initially, the instructors' dilemma of using CBT lessons in the classroom may appear to be a lose-lose situation. On the other hand, teacher educators have the responsibility to transform this situation to one of win-win. Given the development/production process and learning principles above, creative and progressive instructors can move ahead in one or more of the following ways. First, use selectively and/or modify current poor courseware. Second, use care and work with vendors before purchasing new hardware and software. Third, utilize professional and summer break time to learn an authoring system. Fourth, develop professional teams for courseware development through grant writing, graduate classes and internet connections. Fifth, be hopeful. New and more user friendly courseware is becoming more available each month in the technology/school reform revolution.

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Recursive Templates in Multimedia Presentations

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One of the most significant developments in contemporary education is the use of computer-generated multimedia interaction as an aid to the learning process. With programs produced by any one of several multimedia packages, educators are able to impart to their students virtually any concept in a non-threatening, inviting manner. As classroom testimony so well illustrates, these displays attract and hold the attention of students in a unique and positive way. For these reasons, multimedia is looked upon by progressive educators as an important educational advancement.

Nevertheless, in spite of the all the benefits to be gained by using multimedia experiences in the learning environment, many college and university faculty members have, up to now, been extremely hesitant to employ it. It is perhaps a hallmark of our era that educators are burdened with responsibilities which take them far afield of their chosen specialty. Their schedules are committed to such an extent that they presume they do not possess the chronological resources necessary to prepare adequate multimedia interactions for use in their courses. They subscribe to the conviction that quality multimedia interaction requires an unrealistic demand upon their already precious time. As a result, they deprive themselves and their students of what we view as a vital educational asset.

Additionally, there are those in the profession who, in spite of the inundation of automated technology into academe, still feel inadequate around computers. They have never given themselves the opportunity to become familiar with computers and their use, thereby divesting themselves of what ,we feel, is one of the most effective instruments in the repertory of educational tools today.

The purpose of this paper is to lay these false ideas to rest. It is justifiable to assume that, if multimedia preparation would consume an unrealistic amount of time in one's already hectic life, one would have a reasonable excuse for ignoring it. Indeed, if multimedia formulation required only a realistic time commitment from educators, they would be able to familiarize themselves with it. However, it is our argument that exciting and effective multimedia interactive experiences can be drafted within a reasonable time-frame which is within the reach of most individuals. This time-frame, which we call "real time," is a decrease of at least 25% as compared to realistic time, placing multimedia within the grasp of all who are interested in utilizing it for educational purposes.

Moreover, this method of using multimedia can be successfully implemented by anyone regardless of their computer expertise. Neophytes to computers have been trained in these procedures and have produced quality products which are in use today at various agencies in and around the United States. The gains these people have received from multimedia have increased their confidence around computers. Many have left the workshops and continued on their own into realms of computer technology they were only capable of dreaming about a few short weeks before.

The Advantages of Recursive Templates

What is the key to this transformation? What is the secret to producing effective multimedia experiences in real time? The answer goes back to an idea which has been employed for many years in industry: interchangeable parts. Under such a system, one may ,with assurance, take an element from one product and, with little or no modification, incorporate it into another. Time and labor are lessened by not "reinventing the wheel" to meet different situations. Recursive templates were fashioned to empower one to make use of the advantages multimedia offers without the lengthy time commitment while simultaneously permitting one to profit from the labor others have already perfected.

What are recursive templates? They are prepared applications of multimedia programming which enable one to devise effective multimedia interactions in real time. They are recursive in the sense that they are utilities which can be continuously utilized both inside and outside of themselves and can be tailored from within to meet one's individual need. They are, in short, sets of reusable code which can be infinitely incorporated into either other code or themselves.

The advantages recursive templates offer those in academe are numerous. These devices enable the user to propitiously arrange multimedia interactive programs in real time. That is, regardless of other responsibilities, one may, with a minimum of time and effort, generate a multimedia production which will not only impart precise concepts to an audience but will also be a quality piece of work which one can take great pride in presenting and calling it their own. They also foster self-confidence in those new to computer technology, propelling them to further explore the various privileges computing offers them. This, in comparison to typical multimedia training, accomplishes its assigned task and encourages learners to progress further into computer technology.

Recursive templates are easy to use and fit in well with the general pattern of authoring multimedia training. First, one must clearly define the objectives of a multimedia experience, making sure they conform to the general educational guidelines. As is the case in all good teaching, the simpler the notions, the greater the chance for success. Next is the planning stage whereby one marshals the information to be imparted and establishes a flow of data to facilitate a logical transfer of material.

Stage three is where the real benefits of recursive templates begin to make themselves felt. At this point, one has many different avenues to work from. One may, for example, establish an organized plan via storyboarding or outlining, applying those aspects of multimedia deemed most appropriate to the subject matter. Then recursive templates enter the picture. In this process, they are utilized as needed in order to shorten and ease the process of writing as well as to exploit the ideas and designs of others who have formulated these aids to foster greater use of multimedia in the educational process. They serve as both time savers and as windows into the minds of other writers who have favorably applied them in various settings. They are proven ideas in which success in one instance increases the likelihood of success in another.

Our recursive templates are highly organized to facilitate their service in the most appropriate setting. Start-up pages are screens that present the material title, list the designer and developer, and declare the theme of the work. Introduction screens are fashioned to inaugurate any portion of the program. Several can be utilized within one complete session. Menu screens are gateways into the heart of the experience. They present options users can choose from as they progress through different modules of the event. Objective slides list either the goals of an entire program or those of distinct parts. Finally, test screens reinforce the learning gained from the showing through the use of multiple choice, true-false, or text questions.

Recursive Templates in Test Case Studies

To gauge the efficacy of our recursive templates, seminars were held on the campus of St. Ambrose University in Davenport, Iowa to train people in the formulation of multimedia experiences for training purposes. All participants were presented with approximately twenty hours of basic instruction in multimedia technology before they were divided into two separate clusters. Group A served as the control group which was assigned to compose a multimedia instructional event using only the training they had thus far received. The members of group B, on the other hand, were introduced to our recursive templates and their uses before they were presented with this same assignment. All groups had an equal amount of time to complete their work. For our assumptions to be proven true, several statistically significant differences should appear between the control and test groups. Moreover, these variances should be noticeable between participants of different seminars held ,at various times, during the academic year.

Our results up to now have confirmed our hypothesis. Overall, test group members used 52% more icons in the programs they developed than did their control group counterparts. They utilized 42% more proactive screens (screens that call for a decision on the part of the program user) and 53% more screens of all types in their interactions than did members of the control groups. Only test group members included screens with motion in their finished products, although all participants were instructed in the use of motion prior to the final assignment. By these and all other standards by which their products were evaluated, the members of the test groups proved to be more productive and more experimental in their use of multimedia authoring software than did their companions in the control groups. Moreover, the quality of the finished products from members of the test group were decidedly superior to those from the control group..

Furthermore, as we reasoned, the templates engendered a sense of self-assurance for the test groups. They gave those students a feeling of safety not experienced by their peers in the control groups. This confidence empowered them to venture into different aspects of authoring software (such as motion) while those in the control groups were more hesitant to investigate the limitless possibilities of the software beyond the absolute minimum requirements demanded by the assignment. As in any other educational or training situation, the magnitude of this sense of assurance cannot be overstated. Additionally, once the members of the control groups were introduced to the templates, they too were invigorated. As had the members of the test groups, they also inaugurated their own explorations of the bounds of authoring software once they were buttressed by these unique tools.

It should also be noted that St. Ambrose is not the only setting in which our templates are being reviewed. Results from similar work being undertaken ,at the University of Edmonton, corroborate our findings.

What are the essential requirements one must possess in order to use recursive templates? The obligatory hardware and software all multimedia demand are the first necessities. A definite idea of content is another. Finally, one needs a touch of imagination to employ these devices in an educational setting. Enthusiasm, that peculiar element so essential to a satisfactory outcome in this realm, will arise naturally as auspicious multimedia interactions are conceived and imparted to students.

So why should we, in the field of educational technology, consider adopting organized recursive templates in our spheres of operation? Because, they have shown themselves to be effective agents in introducing others to the concept of multimedia authoring, thereby also expanding the role of multimedia technology in the world of education.

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Teaching Word Processing to Teachers: A Working Model

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Computer programs have become widely used and appreciated for over a decade. Educational usage of computer-related technology is becoming an issue of change in K-12 schools around the country. To understand how computers were used among educators, a survey on 45 computer-using teachers from 6 states was conducted to examine how they used computers for their daily work. The results showed that word processing was the primary task that most computer-using teachers (95%) employ. However, a great number of these teachers (84%) used only the basic word processing functions or features to prepare documents as if it were an advanced typewriter. Word processing, with advanced features such as formatting, styling, text analysis, and desktop publishing functions, could serve as a powerful tool to increase quality, efficiency, and productivity but it is essential that teachers become familiar with advanced skills to make a difference in their daily tasks. An effective model of teaching or learning to use the word processor is desirable for teachers to improve their job performance.

The results of the survey suggests a positive correlation between the length of time these teachers used word processing and their confidence level with using computers. However, the teachers' performances differ with their attitudes. Those teachers who held positive attitudes enjoyed exploring the advanced word processing features and seemed to be more creative and productive with these amenities. However, their ability in using advanced word processing features for productivity does not significantly grow with the length of their computer using time. More than 85% of the teachers claimed themselves as experienced word processing users since they had used their word processors for over five years and averaged five hours per week at various word processing tasks. Yet, only 6% of these teachers reported knowing how to use advanced word processing features.

To test their skill levels, the teachers from the survey were invited to do a few word processing tasks to create a mock-up document. Many teachers did not seem to know how to fully utilize the word processing program to accomplish the task more quickly. For example, if they desired to delete a line, they started from the beginning of the line and kept pressing the Delete key until the end of the line; or,when they needed to indent a table, they pressed space bar instead of the Tab or Indent key. In fact, most teachers did not benefit from using the word processor at all because they either did not have the knowledge and skills to use advanced features or did not want to explore them.

Most teachers also demonstrated a certain degree of resistance to learning new technologies. The majority of teachers (80%) expressed that they preferred not to change the word processing program they were currently using no matter how much more powerful they found other word processing programs to be. Many computer-using teachers did not even feel the need to get formal instruction. They tended to learn to word process from a self-taught approach. In addition, most teachers felt satisfied with the simple tasks they could do with the basic word processing features and did not pursue various methods to prepare documents in a more efficient and professional manner by using advanced word processing features.

Rationale for developing an advanced model

Vockell & Schwartz (1992) suggest that word processing programs are a better tool than a typewriter. With the help of computers and word processing programs, we can prepare data electronically with pre-defined features or functions and put them into desired document formats. These documents can then be easily revised and customized for various purposes.

However, the process of completing a word processing task involves many elements - computer hardware, software application (word processing) programs, and users. The user is the most crucial component in word processing (Kusek & Anderson-Yates, 1987). Robin Williams (1990) suggests that every user should uphold the highest possible level of quality when using a computer to create text on a page. Such a suggestion is possible, doable, and practical for teachers. However, there is a psychological aspect that needs to be addressed. Townsend (1984) predicted many users would have fears and anxiety about the technology and how it relates to their job. The majority of the teachers in this survey agreed that this anxiety existed when attempting to use this technology.

Since most computer-using teachers employ a word processing program as their major computer application, word processing has become an essential component of basic computer knowledge just as reading is to basic literacy skills. However, most of the teachers do not really master the needed skills and benefit from using such programs. Some teachers become inhibited during the training phase and shy away from using word processing and computer use altogether. Other teachers use only the basic word processing features to prepare documents, employing the computer as if it were an highly developed typewriter. Using word processing as a typewriter is a waste of technology. Still other teachers learn word processing by reading a book or manual. These texts deal mainly with the mechanical components plus lack insights on how teachers can really benefit from using such programs. They also do not provide proper models for using word processing for productivity or work performance improvement. Word processing, if optimally used, can become a powerful tool to significantly increase job efficiency. and communicate with others more effectively. To help teachers maximize word processing power for their work, they must learn how to use word processors effectively and efficiently for their work-related tasks using both basic and advanced features.

Developing a word processing teaching model

To improve the important, but often ignored, word processing instruction, we established a teaching model to encourage teachers to explore the full potential of word processing programs. Since not a single word processing program could best serve all the users to increase the productivity, accuracy, quality, and efficiency for the word processing tasks involved, we matched our word processing needs with the capability available. Various software packages across PC's and Macintosh platforms such as WordPerfect, Microsoft Word, Microsoft Works, ClarisWorks were used to satisfy student's preference. We realized that the capacity of various word processing programs is quite comparable to one another and the functions and features are similar among them.

We first examined the general word processing tasks in which teachers would often engage. An analysis of these tasks presented categories at both the basic and advanced levels of word processing (Alderman & Magid, 1989; Campbell, 1989; Milano & Jennings & Copeland, 1987; Pan, 1991; Simpson, 1993). The basic techniques include basic text editing, cursor control, on-line help, text formatting and styling control, file management, and printing control. The advanced features include macro, search & replace, mail merge, on-line dictionary, outlining, sorting, math, columns, document accessories (such as indexing, table of contents), and desktop publishing functions. A mixture of both basic and advanced features were integrated into the development of individual projects.

The word processing learning experience is more effective with a hands-on approach. For each section, a given project required our students to integrate several different word processing features and skills while developing a document that satisfied the intended purpose. They learned new strategies through the development of their own project and shared their experiences with each other.

Successful word processing instruction involved the following elements:

- Cumulative skills. Word processing skills are interrelated. To get a word processing task done, we have to integrate various features and functions.
- Face the reality. Teachers should work on projects that they need to use in the school.
- Positive attitude and active involvement. Since the word processing is only a tool, the users are the dominator to get the tasks accomplished. Fears should be alleviated by applying learned skills to work-related tasks, such as creating newsletters or writing reports. Certain safety rules such as saving frequently, making back up copies, etc., can reduce the teachers' anxiety and encourage positive attitude. Learning word processing does not require memorization of keystrokes but thorough understanding of the processes involved and sufficient practice.

Phases of the word processing teaching model

Many of the teachers involved had already experienced some word processing prior to learning with this model. Regardless of their skill levels, they all encountered similar types of word processing tasks. The teaching model contains the following five phases:

1) Become comfortable doing word processing tasks (mainly basic features).

2) Be sensitive to the efficiency difference in word processing features.
3) Learn to expand confidence in using word processing and to solve problems while using these programs.
4) Develop professionally creative word processing tasks.
5) Use word processing as a tool for teaching.

Phase 1: Warming up

Regardless of different background, experience, and computer skill levels, all the teachers started learning with the basic word processing operations such as getting into the program, entering text, moving around, simple editing procedures, saving text, etc. Each new session began with a review of the previous learning materials. New tasks were built upon the already acquired skills and experience. Meaningful projects with the integration of various relevant tasks and features served as the key to helping teachers to acquaint themselves with the basic skills. Several sample documents were used as examples for students to model. The teachers started enjoying the power the computers brought them as they became comfortable using the word processor to complete these simple projects.

Phase 2: Learning the efficient alternatives

The greatest advantage of using word processing is its flexibility. After the teachers felt more comfortable with using the word processing, they were eager to become productive with their word processing program. They realized that there were many alternatives or short cuts that could be used to develop their document in a quicker more effecient manner. For example, they used the computer to search for a particular entry instead of searching manually themselves; they took advantage of the computer's memory to cut and paste information electronically. Certain features such as outline, indexing, sorting helped the teachers better organize their documents. Repetitive tasks can be very time consuming for teachers. To reduce the tedious labor of doing the same task repeatedly, they learned to create a simple macro that recorded a few keystrokes and then played them back when needed to reduce repetitive tasks. They also learned to create templates of documents for various occasions so that they didn't have to redo the document from scratch each time. This phase really helped teachers to consolidate their word processing skills and knowledge and become efficient.

Phase 3: Building confidence in problem-solving

Almost all the teachers had encountered some kind of problem or challenge with their word processing documents and/or programs. The most common difficulties new users have is formatting documents and printing with various kinds of printers. Their word processing knowledge grew by sharing these problems and their solutions with each other. The learning process started by identifying and describing the problems each encountered. An open discussion encouraged them to view the operation globally and to explore the possible solutions. The resources from both on-line (help or revealed codes) and printed manuals or reference books confirmed the solution and consolidated their learning experience. Once the problem-solving process was set in motion, more sets of problems and challenges were given to the teachers as exercises for practice. Their confidence level increased significantly as their problem-solving expertise improved.

Phase 4: Being professional and creative

With the recent computer technology, we can easily incorporate both text and graphics to create more interesting documents. Charts, graphs and illustrations can be easily exchanged between users and/or platforms to accompany text and get meanings across more easily. Graphics are available from many sources. Although the graphics formats were complicated, most teachers were able to manage them quite well and developed their own strategies for their preferred word processing programs. We were often inspired to find these teachers artistic with very creative minds. They, too, took pride in themselves when they developed in-house documents containing good taste and quality as if they were created in a commercial print shop.

Phase 5: Applying the learned skills to teaching and other related tasks

Word processing programs can serve as a tool for teaching. An excellent example is found in teaching writing where word processors have relieved student writers from the drudgery of repeated revisions and their attendant recopying (Krull, 1994). In addition, Krull suggests that students pay more attention to what they intend to convey instead of the structure of the paragraph. Word processing programs can assist students on both content and structure. In addition, most word processing programs provide spell-checking, thesaurus, grammar, and text analysis. These features can aid students in improving the quality of their writing. As teachers master the needed word processing skills, they would explore unlimited possibilities of using word processing for their work. One teacher created an encoded paragraph using the search and replace function to develop a game sheet to test student's ability in reading, vocabulary, and analysis. Another turned her word processing program into a test-creation instrument. Word processing, as these teachers identified, is limited only by the teacher's imagination.

Conclusion

In spite of the powerful word processing programs on the market today, most teachers have neglected the importance of a systematic approach to master word processing tasks. This paper presents a word processing teaching model that helps teachers optimize their use of it with efficiency. The survey of computer-using teachers suggests that these teachers did not truly benefit from word processing programs because of their knowledge of the benefits which could be derived. This teaching model has been successful in teaching word processing to many other practicing and pre-service teachers. This model promotes teachers' performance by integrating both basic and advanced word processing features into the learning process.

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Technology Activities: New Ideas for Teaching

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Superior teaching is distinguished by continually searching for diverse ways to present information in suitable yet creative ways. With the increasing use of technological resources in the classrooms, educators have the capability of creating visually appealing instructional presentations that enhance learning. New technologies also afford teachers various ways to transform otherwise monotonous, lifeless tasks into engaging learning opportunities for their students. Lessons incorporating presentation software may highlight skills, concepts, or strategies under consideration. Presentation software—accompanied by video—offers a change from the mundane to the innovative. Educators should take advantage of presentation tools to benefit the visually informed generation of today's learners. Therefore, teacher educators must model innovative uses of technology for the preservice teacher. This article describes four technology projects used in teacher education courses to illustrate and promote technology uses within the classroom.

Microsoft PowerPoint

The presentation graphics program, Microsoft PowerPoint 3.0 (Microsoft Corporation, 1992) is an excellent illustration of how to use a single computer in the classroom as well as developing innovative instructional exercises. PowerPoint is a "new media" program that allows educators to create demonstrations containing text, high quality graphics, clip art, charts or graphs, various types of video clips, and sound which can be projected onto a computer screen, an LCD panel, or a television monitor. By using a laser printer, black and white or color transparencies may also be generated when electronic projection equipment is not available. PowerPoint also offers rich support for students viewing the presentation in the form of outlines or printed versions of the slides.

If the teacher is already familiar with other computer software (especially Microsoft products), PowerPoint is easy to learn. By simply double-clicking the PowerPoint icon , a new file is opened with a blank slide ready for the teacher to choose from a wide variety of professionally designed templates. Each template has its own pre-selected color scheme and styled fonts allowing the teacher greater ease with which to create an adept presentation. By using a PowerPoint template, pre-formatted text is inserted into title and body areas. These areas are easily manipulated with functions to change styles, fonts, and increase and decrease type size if desired. In addition, the body text offers a "build" function which permits words and sentences to appear in a variety of eye-catching ways. For instance, text can emerge from the bottom of the screen, fly off the screen in various directions, and dissolve from one image into another. These effects are particularly useful for highlighting and calling attention to important points in a lesson.

The PowerPoint toolbars provide the teacher with easy access to many tasks offering an assortment of possibilities from cutting and pasting a graphic to applying a shadow to selected text. These various tools have pre-defined settings which can be varied through various menu selections. As teachers create instructional lessons, they can also switch among four views. Each view allows them different ways of looking at their work and offers different capabilities. For example, the teacher is able to inspect a single slide in the Slide View, while the entire presentation may be surveyed all at once in the Slide Sorter View. This latter view is especially helpful, because it offers a panorama of an entire presentation, and permits the arrangement or rearrangement of important points by simply dragging slides to a new position in the presentation scheme.

Electronic presentations give instructors the means to emphasize concepts by selecting numerous fonts to enhance text, isolating specific text using an enlarging facility, and/or selecting miscellaneous colors, sound, or graphics for accent. For instance, a particular word may be stressed in context. Students might recognize a key word in the sentence because it is shown in italics, presented in a distinct typographical font, shown with a particular graphic or is given a unique color. All of these features give the teacher ways to make instruction less tedious while presenting strategies vital for content areas.

An Instructional Module Using PowerPoint

PowerPoint presentations can be used to demonstrate ideas in many content areas. For example, in a unit concerning reading instruction that teaches the topic "author's purpose," an instructor can use text or graphics to feature a particular tone an author is using. First, the instructor creates a slide containing the text to be studied. This text is placed within the Master Title box at the top of the slide. Text editing buttons can be used to control font size, boldness, italics, underlining, and color. The teacher can choose a suitable font that presents the words clearly. For example, a sentence demonstrating optimism might read something like this: "Well, at least I know I'll get a passing grade." In this case, the instructor might choose a Courier or other serif font to give the appearance that the passage is actually out of a textbook or a San Serif font may be chosen to give a contemporary look. Next, using the "font size" option from the tool bar, the size of the text can be increased for easier readability and to avoid distortion when projected by an LCD panel. With the wide variety of color schemes for both text and backgrounds, the teacher is now able to select the most visually stimulating design for the presentation. However, this choice is limited when an LCD panel is used to maximize contrast between text and background colors for utmost readibility.

Following the creation of the passage within the Master Title box, the instructor can then insert the word "OPTIMISM" within the Body Text box and choose the Build function to allow the word "OPTIMISM" to appear on the screen or monitor after the students have had ample time to read and study the tone of the passage under consideration. During the actual lesson, the word "OPTIMISM" appears on the screen to help emphasize the optimistic tone that the author has taken. Since the exercise involves students' ability to discriminate different tones that authors use, students have had an opportunity to assess for themselves the style or tone the author used prior to the identification of the style description in the presentation. This Build tool is particularly useful because it creates the illusion that the computer is interacting with the reader. The students review the text, and the teacher attends to misinformation and improper prior knowledge before advancing to the next slide. The reader's judgments are confirmed or refuted through this simple medium without the requirements of complex and expensive interactive systems.

The use of PowerPoint can make the teaching of content area studies interesting and effective through the use of computer-generated text and graphics. In social studies classes, a similar techniqueto the one already explained can be used to discuss terms such as "civil rights" and by adding a Quicktime movie from Martin Luther King's "I had a Dream" speech the topic can come alive. Mathematics examples in algebra and geometry can be enhanced through the use of the Build and Effects fucntions, the draw tools, the equation functions, and charts and graph to illistrate solutions. The possibilities are limited only by the imagination of the teacher.

In each example, these electronic files also give the teacher administrative advantages in that students who were absent the day of the original presenation can view the lesson in an interactive mode upon their return to class using the PowerPoint viewer. Since the PowerPoint viewer is freeware, it can be placed on computers that do not have the full PowerPoint program such as those in a lab, library, or media center. Teachers can catalog these files for student review. Thus, this approach can also be used for remediation of students who are still having problems with any of the concepts presented in the lesson. Modeling in teacher education courses supply many varied and interesting ideas to prospective teachers.

A High Tech Course Syllabus

With relatively little effort, the most basic piece of course ware, the course syllabus, may be transformed from an uninteresting piece of paper, to an eye-catching presentation using video and presentation software. The course overview, requirements, assignments, instructor policies, and semester projects may be presented by integrating presentation graphics and actual full-motion video modules into a "High Tech" course syllabus.

The high tech course syllabus introduces students to a course in a unconventional way. Similar to the production of high tech instructional modules described above, teachers can use PowerPoint to create slides that describe the major components of the course and the fundamental requirements expected by the instructor. By using the Clip Art or the Insert Picture function within PowerPoint, the instructor is able to insert a variety of graphics that further embellish the presentation to make it not only more interesting but purposeful as well. Suppose the instructor wishes to begin the presentation by introducing basic course requirements. The instructor would choose from the many pieces of clip art Powerpoint 3.0 offers in the categories in academic, business, people, education, or humor, to name a few. After choosing an interesting graphic, for instance a clipboard, the instructor may insert each requirement on a separate bulleted line. The graphic will appear directly on the slide and may be enlarged, reduced, or repositioned by simply placing the cursor and dragging the corner of the box that surrounds the graphic. Such clip art can enhance the presentation of the course syllabus causing students to remain attentive when the instructor chooses to cleverly illustrate a point that he or she is trying to make.

By inserting text into the body of the slide, the text will appear according to the effect chosen from the Effect Box, either flying from one of the sides of the screen or in a dissolve. By choosing the "dim previous points" option, the instructor may further highlight the next requirement. For example, "Attendance is required!" becomes dim as the next point "Punctuality is a must!" appears on the screen. The emphasis provided by the use of these options directs the viewers attention and reinforces the concepts the instructor wishes to stress.

Another way the instructor can create the sensation of motion in his presentation is to transfer PowerPoint presentations onto video so a presentation may be shown on a television monitor attached to an ordinary VCR. Through the use of a video scan converter and computer generated text, graphics may be electronically copied onto videotape. That is, the PowerPoint slides are converted to video. This is accomplished by attaching a video output system such as TelevEyes/Pro (Copyright, 1993, by Digital Vision, Inc.) to a VCR or camcorder. The TelevEyes/Pro converts the output signal from the computer into NTSC composite video. The VCR, which is set to record, will capture each slide as you show it. A click of the mouse will advance the presentation to the next slide. The result is a full-motion video with colorful graphics and text that accompany the video.

In a teacher training course demonstrating test-giving methods, for example, the professor could create slides that include text describing a particular testing procedure. Important directions for giving the test could be emphasized on the screen. After converting the screens to video, the slides can then be edited with previously created video of the test-giving procedure. For instance, the first scene could show slides containing text describing the highlights of the procedure. The next part of the presentation could then include an actual video recording of the test procedure. The video provides students with modeling of the test procedures, and the PowerPoint slides serve to highlight the points the instructor wishes to stress.

The combined use of presentation software and video technology to enhance instruction is receiving increased attention today. Teachers from all disciplines are striving to change the way instruction is presented by transforming boring instructional units into engaging opportunities for their students. Presentation software accompanied by video is, indeed, an entertaining and effective means to achieve this end.

Overview of Technological Developments

keeping abreast of the rapidly changing developments in hardware, software, telecommunications, and the uses educators are making of this technology, are extensive problems. Fortunately, an electronic source on the Internet helps keep educators updated. The resource is called EDUPAGE, and it contains summaries of news stories about information technology. Once you subscribe, it is delivered to your computer three times a week. If you wish to subscribe to EDUPAGE, send an e-mail message to listproc@educom.edu. In the body of the message type: subscribe edupage Your Name (First, middle initial, and last name). Do not put anything on the subject line, and do not put any other words in the message box. When you receive your first Edupage you will find not only excellent summary paragraphs about current events, you will also receive information about the EDUCOM REVIEW and the EDUCOM UPDATE, and how to obtain archive copies of previous publications by Educom, which is a consortium of colleges and universities interested in information technology. The headquarters are in Washington, D.C.

Once you review EDUPAGE, you will see that this is a valuable resource for students in technology classes or teacher education courses where technology is being used for the delivery of instruction. Each semester, we require students to obtain an e-mail account through the University. The first thing they receive is a forwarded copy of EDUPAGE. We then discuss information found in the articles as a kick off at the beginning of class periods. After a few class periods, we stop forwarding EDUPAGE to students because they are required to join the listserv for themselves. Although all of this may sound simplistic, this activity is of great value for several reasons. First, this becomes the reason many "reluctant" students open an e-mail account. Second, EDUPAGE gives them something pertinent to read electronically, and this stimulates their interest in finding other resources on the Internet. Third, students learn about listservs and how to join one, a useful thing to learn about. Finally, the information found in EDUPAGE presents up-to-date data about technology that today's teachers must master.

If you teach classes in which students simply need basic information about what is happening with technology, you can use information found in EDUPAGE to make a very effective PowerPoint presentation. In one recent lecture, we discussed how technology impacts work, communications, entertainment, science, and transportation. Using information from EDUPAGE and snappy graphics from PowerPoint as well as video-captured images of pertinent objects, we were able to speak about telecommuting trends (up a million people in 1993), the fact that researchers are designing a digitized, computerized complete model of the human body, how a headset from a virtual reality system is being used as a magnifying tool for people with severe vision problems, and much more. The audience was particularly interested in recent disclosures about the IRS using huge parallel computers, relational databases, and expert systems to hunt for tax evaders, how the Intelligent Vehicle Highway System will give information about traffic accidents, and delays to wristwatch pagers and PCs.

In sum, keeping abreast of late-breaking technology news via EDUPAGE and transforming information into a PowerPoint or some other presentation can be an effective way to keep you and your students current in a rapidly evolving field. There are other numerous listservs that you can also access to obtain information about specific content areas of interest. Just get on the Internet and you should be able to find more listservs than you can possibly manage.

Creating Student-made High-Tech Texts

Although there are fine textbooks dealing with technology, much information in them is a bit stale because of the passage of time between their writing and their publication. Add a review process and a backlog of orders in your bookstore, and the information in the texts has aged even more. A few years ago, we started asking students to bring articles from current technology journals to class each week so we could discuss really recent developments. Students were encouraged to seek out articles of special interest to them on such topics as distance learning, the Internet, CD-ROMs for children, and so forth. Discussions of the articles led to the desire on everyone's part to make a collection that all students could access.

Sensing that we had stumbled onto a good idea, we decided to embellish it. The next semester, we asked students to become editors of books which contained a collection of articles of interest to them. Students selected a topic such as those noted previously and went off to find current articles that dealt with these topics. Soon we started receiving texts such as: Zap! The Power and Promise of Electronic Mail and Education; Meeting Individual Needs with Technology: Helps for the Real World; Rainbows of Technology (about dealing with cultural diversity through technology); Computers and Foreign Languages; and Language Arts and Technology. The students were extremely pleased with their products and recommended that we continue having students create texts in that and other technology courses.

We chose the format of an edited collection of articles for several reasons. First, we wanted students to dig into a variety of the technology journals available today. Second, we wanted students to have a central theme so they could look in greater depth at a topic. The collection strategy accomplished both of these ends. As authors, students wrote prefaces to their books. They discussed the topic of the book, why they were interested in that topic, and they gave an overview of the articles contained therein. Next, the authors wrote one-page introductions for each of the 13 to 15 articles they included in their books. The introductions highlighted the salient ideas and facts contained in each article. At the end of their books, the authors placed a summary which was designed to synthesize the major ideas they had gleaned from all of the articles. The summaries were not to be a simple restating of the articles. Rather, the summaries gave the authors the opportunity to pull together the important understandings they derived. A table of contents was included, but student authors were not asked to index the information. The individual books were shared with the entire class during one or more of the final classes of the semester. Each proud author, therefore, had an opportunity to be an authority for the day on a special topic.

An added benefit from this textbook-making activity was that students scoured the library to determine which journals contained information pertinent to educational technology. The following journals were found to be useful to many of the students: *Computers in the Schools Journal; Computing Teacher; Educational Computing; Educational Technology Magazine; Journal of Educational Computing Research; Journal of Research on Computing in Education; Technology & Learning Magazine; and Tech Trends.*

Some students found information on the Internet to include in their books. For instance, everyone was happy to find that *The Journal of Technology Education* is online. To subscribe send the message subscribe JTE-L to listserv@vtvm1.cc.vt.edu, and be sure to include your full name after the subscribe message.

Having students create their own high-tech texts has been a valuable activity in our technology courses. Not only have students learned to pursue their own avenues of interest, but they have learned about valuable periodical and online references dealing with today's technology developments. There have been hints from the publishing industry that more and more journals and texts will be available electronically either on the Internet or through bookstores or computer software stores. Until publishers speed up their delivery of information, we will continue to have students create their own texts. Even information that is just a few months old is better than last year's information.

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Producing Electronic Books: Creating and Using the CD-ROM Version of the Annual

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Since the 17th century, the textbook has been one of the primary classroom tools. From the early grades through graduate school, textbooks - stacks of paper bound between two covers linearly arranged - have dominated education (Siegel & Sousa, 1994). However, with the introduction of personal electronic publishing (PEP) tools, educators at all levels have found a new way to quickly and efficiently produce a wide range of publications that meet specific needs. Those needs may relate to a third grade science lesson, a college history course, or the knowledge dissemination needs of professional and scholarly organizations. Desktop publishing programs like PageMaker make it possible for individuals, schools, and small organizations to produce books, brochures, and posters at a quality level that would have required professional specialists and thousands of dollars a few years ago. Today another type of software, for creating "electronic books," is affordable, widely available, and increasingly popular. In this paper electronic books are publications available in electronic form that can, at a minimum, be searched and read on the screen of a computer. By searched we mean there is some means of finding material on particular topics - keyword searches or full-text boolean searches, for example. E-books may be text-only but an increasing number of programs can be used to create electronic books that include not only text, but pictures, animation, video, and sound. In addition, while the ability to search for relevant information is a minimal requirement, several programs available today for under $1000 (some are actually freeware or shareware with fees under $100), can create interactive electronic books that can be queried, searched, and explored through non-linear links that connect different parts of the electronic book in a weblike structure. Some programs let authors create the links readers will use to navigate the books information landscape; others offer this feature and also allow the reader to add their own links. "Books" are no longer static, linear, and relatively passive medium of instruction. The purpose of this paper is to introduce one approach to creating electronic books using FolioViews and to describe the use of the program to create a version of the Annual that was stored on a CD-ROM.

Introduction to FolioViews

Among the pioneers of personal electronic publishing tools is a company in Provo, Utah, Folio Corporation. The company's software, *FolioViews,* is used by more than 80 commercial publishers (Murray, 1993) to produce a variety of electronic publications - from large databases that can be quickly searched for data to electronic versions of classic literature that can be read in a traditional linear fashion or searched for keywords or references to specific topics. FolioViews is not an improved word processing program or desktop publishing package. Instead, it is a powerful package for creating electronic rather than paper-based publications.

A typical screen at the beginning of a Folio electronic document includes a title bar with the name of the document, several menus of commands at the top of the screen, and a Toolbelt on the left side of the screen. The Toolbelt is a set of icons for routine operations. The TOC icon, for example, brings up the table of contents for the document. The Query icon starts a query. The program supports full boolean searches using AN, OR, NOT and other operators. The Backtrack and Show Trails icons are discussed later in this paper. Folio also has a Status/Quick Help Line at the bottom of the screen that tells you where you are and offers suggestions and guidance.

One of the problems in electronic publishing has been the task of getting text into electronic form. Traditionally, the two most common methods have been optical scanning and rekeying. You may type all information directly into *FolioViews*, adding formatting and organization as you go. That, however, is very labor intensive. A better alternative is to import unformatted ASCII text into the program and add paragraph and character formatting (called styles by *FolioViews*). That is still labor intensive since you must format all the material if it is to have any of the look and feel of a professionally prepared document. Fortunately, there is a third alternative that reduces the formatting to a minimum. FolioViews will import documents from popular word processing programs including Microsoft Word and WordPerfect. The imported files maintain most of the formatting codes and the appearance associated with each style can be changed within the program. Folio can also use paragraph styles from programs like Microsoft Word to create a table of contents and document structure.

A powerful feature of the electronic books is the search options they offer. This was one of the reasons why the Technology and Teacher Education Annual was converted to an e-book stored on a CD-ROM. *FolioViews* offers five powerful ways to link information. For example, using *jump links* each item in a list of topics can be linked to additional material on that topic. *Popup links* such as text in a special color can be clicked to bring up a separate window which may contain text (such as footnotes) or an in-line graphic (e.g. a graphic associated with nearby text). *Object links* cause a separate window to appear on screen which contains an object (such as an out-of-line graphic). *Program links* cause another computer application (such as a spreadsheet or movie player) to open and run. And *query links* perform a query or search.

One of the problems of navigating large, complex documents is getting "lost in cyberspace." There is so much information, and so many ways of going through the information, that getting lost is a common occurrence. Two features in *FolioViews*, help you retrace your path through the information: *backtrack* and *show trails*. Folio's electronic versions of *bookmarks, headings, footers*, and *highlighters* are also helpful and work much as they would in traditional books or magazines.

Folio also indexes every word in the *infobases* it creates. When you enter a query such as "interactive video and social studies" the program will locate every paragraph in the document that includes both terms.

An infobase is structured as a set of levels. Levels provide hierarchical organization for instructional materials as well as aid in the design and layout of your information. Levels contain structurally related blocks of information. For instance, all the chapter titles in a book should be tagged at the same level. Then, when Folio creates a table of contents all the chapters can be formatted the same. Folio also allows queries to be applied to only certain levels. A search could, for example, be applied only to chapter titles or main headings.

In Folio tables of contents (toc) are generated from the levels you create or assign. The entries in the toc are linked to the appropriate section of the infobase automatically. Toc are expandable and collapsible to allow you to choose as much information as desired, and get to where you need to be quickly. *Shadow files*, which are overlays of an infobase, have been provided to facilitate group collaboration. For example, an instructor could assign each student in a class his or her own shadow file and that would allow all of them to work on one "book" simultaneously while keeping their notes and annotations separate from one another.

Finally, to help you distribute you electronic books to others free of charge (noncommercial use only), *FolioViews* comes with a *Viewer* application that allow others who do not have the full program to use the infobases you have created. The Viewer lets you use standard Folio navigation tools, the TOC window, and search commands. The standard Folio program and the Viewer also allow users to print copies of pages or sections of the infobase.

Procedures Used to Create the Infobase Version of the SITE Annual

To publish the Technology and Teacher Education Annual, the volunteer Annual editors revise and check hundreds of papers, then pour the edited files from fifty different word processors into Aldus PageMaker and format them in the Annual style. One copy of the Annual is then produced on a 600 dpi laser printer and sent to the commercial printer.

For the 1995 Annual much of the final editing was done in PageMaker. Thus, the final version of the Annual was available electronically only in a collection of PageMaker files that took up approximately 20 megabytes of space on a Macintosh hard drive.

FolioViews and PageMaker both assume the raw material they will be working with are standard word processing or text files as well as graphics files. Neither program reads or exports files in the format of the other program.

FolioViews Version 3 currently accepts files created by a wide range of formats including: Folio Infobase, LEXIS/NEXIS, L/N Alternative, ASCII text, generic WP text, RTF, WordPerfect 5.x, Word for Windows 2.0, and Word for DOS 5.5. Next year we will do all necessary editing in a word processing format such as Word for Windows and import those files into both PageMaker and Folio.

This year it was necessary to export files from PageMaker. The exporting formats supported by PageMaker 5.0 were: DCA/RFT, MS Word for DOS 3.0, MS Write for Windows 2.0, Rich Text Format, Text-only, WordPerfect 5.0, and XyWrite III. The document-exchange format RTF (which stands for Rich Text Format), Word for Windows 2.0, and WordPerfect 5.x formats were used to export files from PageMaker. Unfortunately, PageMaker divides documents into stories. A single article can have many stories - one for the title, one for the text, another for each illustration, and still another for figure and table titles. PageMaker's export function was set up to export single stories and it does not export graphics at all in most circumstances. The process of converting PageMaker files into Folio files required hundreds of hours of manual, file by file effort. Much of this could behave been avoided had the final editing been done in a Folio-compatible word processor, however.

When the Annual files were finally in the Folio format the infobase was created and tested. Then a copy of the infobase was transferred to a CD-ROM using a JVC Personal ROMMaker. After the infobase was tested and other files were added to the CD-ROM a copy was shipped to a CD mastering facility for duplication.

Issues to Consider When Designing Electronic Books

The first and most annoying challenge designers encounter in creating electronic texts is learning and using more specialized computer software. Fortunately, FolioViews is relatively easy to learn and use. Although it is possible to begin using FolioViews in less than an hour after opening the box, designers may still need to learn enough simple commands, or scripting, to indicate to the Folio Flat File (FFF) and Folio Search & Replace (FSR) utilities how you are organizing your texts and building your publications.

Creating the electronic form of the Annual was relatively straightforward from a design perspective because the intent was to create a version that used the same format as the printed Annual. Other types of projects, however, may need to consider the question of linear versus nonlinear reading styles. Will most users start in one section and proceed through the next section and the next? Or, will they skip around using the query and search features? Many sections of traditional print matter are written on the assumption that the reader has already read other sections of the document. That may be less likely with electronic books and should be considered. As an author you may need to provide clues to help readers retain a sense of where they are in the material, or even how much material there is (Boiling, 1994). Future generations are not likely to read from A to Z, but will start wherever they want and come out wherever they want. "...you can follow various lines of thought," as CD-ROM publishing guru Rick Smolan once observed in a Forbes interview, "but the lines still have to be there. Five different stories may be interwoven, and you can choose what story you want to go on with, but that doesn't mean there's no story. I mean, while we're sitting here, other things are happening to our friends and families" (Edwards, 1994). In another words, the traditional linear model will change, but it won't go away.

Benefits

Currently FolioViews supports DOS, Windows, and Macintosh platforms. A Folio VIEWS electronic book may be created on one platform and used on another platform. It can also be used on a stand-alone computer or in a networked environment for users to access, read, and write. In a classroom environment, several students could collaborate, post notes, and add information at any time to an infobase the entire class has access to or work on personal *shadow* files of an infobase. In addition, the program supports an unlimited number of simultaneous users in read-only mode. An electronic book or infobase would thus support much more interactivity than a traditional book, especially in a networked computing environment. The disadvantage, of course, would be that the infobase is not as portable as a traditional print book. It cannot be read on the bus from campus to apartment, for example. However, as more and more students (and faculty) acquire laptop computers and powerful telecommunications connections at home, the importance of this limitation will be reduced.

Electronic books are also more fluid than traditional books. Because e-books can be updated easily and distributed inexpensively on disks or CD-ROMs, the idea of *editions* is less clearly defined in electronic environments. Traditionally, an edition of a printed textbook may be used for three to seven years. A mistake or error in a book with a first print run of 10,000 copies is likely to be a problem for at least 10,000 readers. However, errors and weaknesses can be corrected as soon as they are discovered in electronic books. Romiszowski (1994) has referred to this as the "rolling remake" model of material update and improvement.

The author of an electronic textbook could update it every year (or semester) and distribute the new version to adopters at a cost far below that required to update a print textbook. However, frequent updating can produce its own set of problems such as instructions about the location of information that no longer apply because revisions have shifted the location of information. (This can be handled by using location names rather than page numbers and anchoring the name to the material rather than the page or chapter location.) Increased use of electronic books may move us closer to the "just in time" production of documents. The time from idea to final product may become much shorter, along with the useful lifespan of a particular edition. The result would be less use of natural resources such as paper stock and less production work such as typesetting (Satran, 1994). However, the workload of the information developers such as authors and designers would probably increase because new editions would be required more often.

Another advantage of electronic books over print books is the ability to add additional media such as color graphics, video, and sound. The principles of "sandbox (a multimedia environment), dirty learning (total emotional and physical immersion), and mucking around (no ulterior correct way in mind) are keys to effective learning in all levels of education from kindergarten through teacher inservice" (Ferris & Roberts, 1989). With FolioViews and similar products, electronic book designers can expand their perspectives and find new ways to incorporate multimedia resources. "With 6000 TV-watching hours prior to first grade and 20,000 hours before leaving high school," as noted by Julie Bao," many of the students attending schools today have adopted a digital style of learning, a style that relies heavily on exciting and interactive screens for the source of information. Influenced by this learning style, printed textbooks and traditional instructional strategies alone can no longer satisfy students' needs" (Bao, 1993).

Conclusion

Electronic books are just beginning to emerge as alternatives to print documents. We do not believe e-books will replace printed books completely, just as e-mail has not completely replaced traditional mail - yet. We do believe that the availability of affordable, relatively easy-to-use programs for creating e-books, such as FolioViews, will be a major factor in increasing both interest and activity related to this type of document. Just as PageMaker and the laser printer helped established the now billion dollar industry of desktop publishing, e-book creation tools and inexpensive distribution media such as floppy disks and CD-ROMs may make the last five years of the 20th century the *era of the e-book.*

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TELECOMMUNICATIONS: PRESERVICE

Over past years, the telecommunications section of the *Technology and Teacher Education Annual* has provided a history of the evolution of telecommunications and teacher education. The introduction to the Telecommunications Section of the *1991 Technology and Teacher Education Annual* suggested,

> The Internet provides a telecomputing network for schools, colleges, and departments of education which links them and offers opportunities for interactions and collaboration. The next logical step is extension of this national inter-university network to the public schools. (Bull & Anderson, 1991, p. 108)

At that time several statewide public school Internet systems in Virginia, Texas, Florida, California, and other states had been planned or implemented. The introduction to the Telecommunication Section of the *1992 Annual* notes formation of the Consortium for School Networking (COSN), founded to encourage K-12 networks. COSN endorsed the position outlined in the previous year's *Technology and Teacher Education Annual*:

> In a position statement to the U.S. Secretary of Education, endorsed by representatives of more than fifty educational organizations and state departments of education, the Consortium for School Networking called for extension of the Internet to public schools on a nationwide basis. (Bull & Robin, 1991, p. 464)

By 1993 it was clear that the Internet would serve as the primary communication channel linking K-12 networks across the nation. The introduction to the Telecommunications Section of the *1993 Annual* also notes rapid growth in private enterprise networks joining academic and research networks on the Internet. In 1993 the Society for Information Technology and Teacher Education first announced a pilot Internet server for teacher education. (Bull & Hazlehurst, 1993)

In 1994, the emergence of Gophers as an Internet archival mechanism was one of the major developments of the year. The introduction to the Telecommunications Section of the *1994 Annual* noted, however,

> Although Internet gophers are evolving rapidly, other graphical client-server tools are also maturing. The Mosaic interface is one of these tools. (Bull & Becker 1994, 629)

That initial promise has been confirmed by the developments of the current year. As a result of the World Wide Web and graphical browsers such as Mosaic and its derivative, Netscape, a fundamental change in the way the Internet is used has occurred.

Internet protocols such as the Serial Line Internet Protocol (SLIP) and the Point-to-Point Protocol (PPP) make it possible to access the World Wide Web, albeit slowly, through a modem. A number of states are also serving as laboratories exploring ways to bring more direct high-speed connections to schools. The current year introduces promising developments as well as issues to be resolved.

Internet Tools and Resources

In the lead article for this year's telecommunications section, Cleb Maddux, LaMont Johnson, and Steven Harlow ask, "Teacher Education and the Internet: Where Do We Go from Here?" The authors have argued eloquently in the past that schools acting alone cannot solve societal problems, and that uncritical adoption of educational technologies can lead to a cycle of disillusionment and abandonment of promising innovations. In this year's Annual, they suggest that "... while we have always tried to promote a skeptical and cautious optimism about educational computing applications, we are, for the first time, tempted to contribute to the hype about a computing application." The Internet's emerging capabilities for graphics, sound, and animation appear to have played a major role in this enthusiasm.

Roger Geyer describes the way in which telecommunications and hypermedia have converged in the next article in this section, "The Teacher's Ultimate Classroom Resources: Mosaic and the World Wide Web." Multimedia and the Internet is also the theme of the succeeding article by Linda Baggott, Niki Davis, and Bruce Wright, "Multimedia Telecommunications: Services for Professional Development." This article describes multimedia projects conducted via the Internet in the United Kingdom.

Although the Internet and multimedia are promising educational technologies, older technologies such as LISTSERV mailing lists first created on the BITNET network are likely to remain popular for many years to come. Sue Espinoza and Evan Yeager describe how such tools can be used in teacher education programs in their article, "Creating LISTSERV Lists for Teacher Education Enhancement."

Linking K-12 Schools and Teacher Education Programs

Use of networks to connect teacher education programs and K-12 schools is one means of employing them as a communications tool. Several articles in this year's Telecommunication Section describe programs developed for this purpose. Cathy Gunn describes a program at Northern Arizona University that links teacher education students both with K-12 schools and with preservice teacher education students at other institutions in "Telecommunications Projects Designed for Preservice Students." Phillip Makurat describes a similar program at the University of Wisconsin at Whitewater in "Using Telecommunications to Connect Preservice Teachers and Classrooms."

Emmett Floyd describes a university-public school partnership in North Carolina in "LearningNet and EastNet: Creating a University/Business/Schools Partnership." Bonnie Beam describes a second North Carolina university-public school outreach program in "WCUMicroNet: Putting Purpose into the Network. Finally, Greg and Anthony San Nicolas describe use of public school-university linkages as a tool for recruiting prospective educators in Guam in "Interactive Technologies in Teacher Recruitment: Linking School to College."

Virtual Communities

The rules, learning methodologies, and forms of etiquette in communities established through telecommunications systems sometimes differ from those found in traditional educational institutions. Adrianne Bonham, Lauren Cifuentes, and Karen Murphy discuss some of these differences in "Constructing Cultures in Distance Education." The learning environment created through a network known as the Multi-User Simulation Environment (MUSE) is described in "A Look at Communication Patterns on the MariMUSE: Understanding How Children Learn" by Sara Zimmerman, Ward Zimmerman, Michelle Capen, and William Blanton. Michael Clay and Robert Grover describe strategies for faculty involved in distance education courses.

The Internet and Teacher Education

The final two articles in this section describe general ways in which the Internet may be incorporated into teacher education programs. Sue Espinoza and LeAnn McKinzie describe a variety of ways in which the Internet may be incorporated into teacher education programs in "Internet Initiatives for Teacher Education." Greene, Robbins, Riley, and Barnes outline their recommendations in "Instructional Use of the Internet: Role of Teacher Education."

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Teacher Education and the Internet: Where Do We Go From Here?

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Since its beginning in the late 1970s and early 1980s, modern educational computing advocates have indulged in wide advocacy of a series of hardware and software innovations that have been hailed as panaceas for a host of educational problems. We have often argued that we should avoid these recurrent cycles of unreasonable optimism, unrealistic promises, and uncritical adoption, because they often lead to disillusionment and abandonment of potentially useful innovations, and because they contribute to a backlash against the use of computers in teaching and learning at all levels.

We believe it is unwise to pin too much hope on technology for solutions to problems of societal scope and magnitude. In our opinion, 30 minutes a day (when even this much is available) of student use of any piece of hardware or software, regardless of its educational value, will be of less benefit than a bandaid in treating the societal running sores of widespread cynicism, general alienation, poverty, dissolution of the family, crime, substance abuse, drive-by shootings, child and spousal abuse, an incredible array of other violent acts, and a host of other complex, shocking, and catastrophic social ills. Nevertheless, a wide assortment of reports of prestigious panels and committees, beginning with the naive and jingoistic *A Nation at Risk*, imply (if they do not declare) that schools acting alone can solve these societal problems, and that technology can and should play a major role in "reforming" our schools so that they can accomplish this miracle.

We do not believe that there is anything that schools *by themselves* can do to solve the problems listed above, although there are certainly things that we can and should change in the way we carry out our educational business at all levels. However, we believe that we should resist the temptation to accept the role of primary actors in the new educational reform movement. We should reject a leadership role because the success of the movement will be judged by whether or not the country's social problems are solved. Since no single cultural entity can hope to solve these complex problems, the educational reform movement is doomed to be perceived a failure, and we do not want technology to take the inevitable "hit" for that failure.

However, while technology and the educational reform movement is a fascinating topic, it is important enough and complex enough to deserve and demand a forum of its own. Our point in this paper is that while we have always tried to promote a skeptical and cautious optimism about educational computing applications, we are, for the first time, tempted to contribute to the hype about a computing application. The application that we find so promising and so exciting is telecommunications, specifically the use of the Internet by students and teachers.

This is ironic, since until now, we have frequently said and written that while we have always thought telecommunications to be of great potential educational benefit, that potential has been unrealized and untapped, and its educational value rendered negligible by a host of practical, financial, and technical problems. The wide availability of the Internet, together with plummeting costs for modems and other hardware have relieved many of these problems and have made telecommunications a practical teaching and learning tool in some of the nation's schools. If the Internet (and its eventual successors) can be made available to most teachers and students, it has the potential to bring the world into the classroom. It can empower students and improve problem solving ability by bringing about a new relationship between children and information. It can expand the horizons of students everywhere, and make quality information equally accessible in both rural and urban settings.

However, as exciting as it is, the Internet is not a solution to all our educational problems and concerns, and it should go without saying that it will not and cannot solve our sweeping societal problems. Nevertheless, many educators, educational publications, and the media at large are once again setting the public up for disillusionment and disappointment by making excessively optimistic promises about the educational benefits of the "information superhighway."

Resisting the temptation to be overly optimistic about the Internet is difficult, however, because it is such a unique and potentially beneficial learning and teaching tool. However, like any tool, it will solve certain problems while creating others. Unfortunately, the literature on educational uses of the Internet tends to exaggerate the problem-solving potential and ignore the problem-creating potential of the network of networks we call the Internet.

One of the current authors has published a lengthy discussion of seven problems involved in using the Internet in teaching (Maddux, 1994). Briefly, these include the following:

1. *Access and the Internet.* The problem here is the temptation to believe that once students and teachers have access to the Internet, they will automatically use it in educationally beneficial ways. Although access is important and necessary, we must not assume that the presence of the Internet in the classroom will guarantee that it is used in ways that will carry educational advantage. If we have learned nothing else in the past ten years of educational computing, it is that mere exposure to computing carries no particular benefits, and that the value of a computing application depends completely on the way it is used.
2. *Antiquated hardware and software.* Many schools (perhaps most of them) are still operating with first generation computers. In addition, few of these computers are equipped with modems and very few schools provide telephone lines to any classrooms, much less to every classroom. Predictably, it is mostly in wealthier, suburban school districts where we find modern machines capable of running graphical programs such as Windows and Mosaic, where each machine is equipped with a modem, and where telephone lines are installed in a number of classrooms. It is obvious that if this problem is not solved, and if the Internet becomes a valuable teaching and learning tool, there is danger that children attending schools in middle to lower socioeconomic neighborhoods will be denied this new educational tool, thus becoming even more educationally impoverished compared to their peers from well-to-do districts. Unfortunately, colleges of education are frequently little better off than public schools with respect to quantity and quality of hardware and software. In fact, many college of education computer laboratories are not nearly as well equipped as elementary school labs in the same community.
3. *Charges for Internet Access.* The Internet is not currently free, but there is often no direct cost to public schools since the Internet is subsidized by the Federal Government. Access itself is frequently supplied by an organization such as a university, which usually does not pass on the unsubsidized costs to public school users. However, no one knows what the coming privatization and commercialization of the Internet will mean to school children and teachers. There is a danger that when the government no longer subsidizes the Internet, and if millions of school children begin using it, end-user fees will be charged. Even if these fees are nominal, such charges would effectively price the Internet out of the reach of many schools.
4. *Support and the Internet.* In order for teachers and students to learn to use the Internet effectively, teachers must be trained and someone must be designated to carry out this on-going training and to provide other needed support. Both technical and curricular support and training will be needed.
5. *Lack of Coherent Structure, Stability, and Documentation.* Those who have used the Internet know that it can be difficult to locate desired information. Although this situation will continue to improve as search utilities continue to be supplied and refined, the increasing amount, diversity, and complexity of accessible information will mean that searching the Internet will continue to require sophisticated knowledge and skill as well as frequent updating as the Internet changes. Support personnel will be needed to answer questions, supply ongoing inservice education, write and update documentation, inform teachers of new sources of information and how to access them, and provide many other consultative functions.
6. *Censorship and the Internet.* Many school districts have already had unhappy experiences related to inappropriate material that can be found on the Internet. Unfortunately, some of these districts have reacted by imposing censorship on users of the Internet, or on prohibiting its use entirely.
7. *Quality Control and the Internet.* It can sometimes be difficult to determine which information on the Internet is authoritative and which is not. We believe this situation will improve as the Internet matures. There will be more peer review for scholarly information, and more magazines and journals will begin to publish in electronic format. Nevertheless, the fact that anyone can post information on the Internet will mean that there will always be a problem in finding the highest quality information available.

None of the above problems are insoluble. Focusing on how best to use the Internet is a decision we can make, and our work as editors and reviewers for journals should reflect that decision. Scholarly organizations such as the Society for Information Technology and Teacher Education should publicize this problem and emphasize that journals and other publications under their control seek articles with such an emphasis.

The problem of antiquated and scarce hardware and software is never-ending. School boards and university presidents must be convinced that public schools and colleges of education have a need for a yearly budget. Again, scholarly organizations could help send this message. Additionally, educational computing advocates should attempt to make this point in writing and send such articles to journals that are commonly read by educational decision-makers at all levels.

The problem of charges for Internet access is a critical one. If end-user charges become a fact of Internet usage, then Internet usage will never become common in most schools. The simple truth is that most teachers are given no yearly budget whatsoever, and most school boards are unlikely to authorize teachers to use a service that results in a regular, monthly fee, especially if that fee varies according to type and duration of use, as the private sector has proposed.

There are two possible solutions to this problem. One is that the federal government continue to subsidize the Internet. However, the decision has already been made to halt this subsidy and turn the Internet over to the private sector. Then too, there are at least 40 million public school students, and it is unlikely that any governmental subsidy could accommodate such a huge number of users. The other solution involves requiring cable operators, telephone companies, or others who may supply Internet access or telephone lines to provide such services free of charge to public schools (thus passing the cost of school access on to other customers). However, the newly Republican-dominated House and Senate seem especially unlikely to vote for this much control of the private sector, or to take any step that would prevent companies from making a profit on services provided to schools. What we believe is needed is an approach to regulation that is not so firm that creativity and innovation are stifled, but which is firm enough that the Internet is not priced out of education.

We do not know the solution to this problem. However, as individuals and as members of scholarly societies, we believe that we should actively lobby lawmakers to avoid any arrangement that would require schools or teachers to pay a fee for Internet usage. We believe that solving this problem should become a major priority for the next few years. If end-user fees are once imposed on schools, it will be difficult, if not impossible, to remove them.

Solution of the problem of lack of support must begin with convincing school board members and other policy makers of the need for support personnel. One of the most effective strategies we have found, both to "sell" such individuals on the need for the Internet as well as for the need for support personnel are hands-on Internet workshops at school board meetings and meetings of school district administrators.

The problem of lack of structure, stability, and documentation can also be solved through the hiring of support personnel. These technical and curriculum experts will be the key to stimulating new and creative Internet use that is consistent with existing district goals and objectives.

The censorship problem represents a major threat to Internet use in the classroom. The Internet's strength is the great diversity of information it contains. However, the disadvantage is that state of the art scientific data and opinions of international experts in every field of endeavor reside almost side-by-side with material that ranges from just plain silly to profane and pornographic.

We believe the solution to this problem does not lie with censorship. Even if we were not morally uncomfortable with such a practice, it is practically impossible to deny an Internet user access to specific inappropriate information. A determined and skilled user can circumvent practically any barrier we could create and find an alternative route to desired information. Then too, censorship requires that someone make a judgement about what is acceptable and what is not. In some extreme cases, such a judgment is not too difficult, and some material would be judged inappropriate for children by almost any reasonable person. However, most material does not lend itself to such clear-cut opinions. As one of the current authors has observed:

> The problem is that what is acceptable or objectionable is not usually a matter on which we can all agree. Perhaps more to the point, almost everything is objectionable to someone. This being the case, how do we establish what to censor and what not to censor? (Maddux, 1994, p. 40)

We believe that school districts should adopt a policy concerning appropriate uses of the Internet. Some districts have found it helpful to have students and parents sign an agreement relating to profane and pornographic material. Such a policy should clearly spell out rules and consequences if the rules are broken. Such a policy should also include regulations relating to posting or downloading of copyrighted material, viruses, or other inappropriate material. We believe the key to solving this problem is preparation and discussion by school boards, PTAs, principals, parents, and other interested parties before a problem arises.

The problem of quality control can be a strength as well as a weakness. Children certainly need to learn that everything that is published is not necessarily valid, true, or valuable. In addition, support personnel can help with this problem, which will become less of a problem as the Internet matures and new methods of ensuring quality information are developed.

There is an additional problem that we believe is creating barriers to educational uses of the Internet. This problem is the current lack of computer integration into the curriculum at all levels of schooling. Although we have frequently argued that computer labs will probably always be necessary in schools, we also believe that teachers of all subjects must integrate computers into their own instruction if they are to have a significantly beneficial effect on education. We believe this is important at all levels, but is critical at the university, not only in colleges of education, but in courses across the entire campus. It is a truism that new teachers tend to teach as they have been taught. Therefore, it is critical that they see the value of computers in teaching throughout their public school and university careers.

Although some university professors are beginning to use technology in their teaching, this is occurring far too slowly. It is particularly unfortunate that college of education faculty are not leading the way in integrating the use of computers in non-technology-oriented courses. This reluctance to use technology in colleges of education has several causes:

1. Many teacher education programs are afflicted with poor quality and limited quantity of hardware and software. As we have already said, we must continue to try to emphasize our needs to university presidents and others responsible for budget allocations. This will be a "hard sell" in these days of budget cuts for higher education, but it is critical that colleges of education receive their fair share of funds dedicated to technology for instruction.
2. There is a lack of expertise in the use of information technology in teaching among non-technology instructors in colleges of education. One way to reduce this problem is for those of us who teach technology courses to conduct inservice training workshops on the use of computers and the Internet in instruction. We have found many teacher education faculty to be eager to attend such workshops, and the pleasure and effectiveness of using the Internet provides long-term reinforcement that keeps most of them using the Internet and learning more on their own long after the workshops are completed. These workshops have a synergistic effect, also, as students of faculty who begin integrating technology in general and the Internet in particular lobby other faculty to do the same.
3. Many colleges of education have instituted computer laboratories, separate technology faculty lines, and required computer information technology courses. Although these developments are mostly beneficial, they sometimes have a subtly discouraging effect on integration. This occurs if other teacher education faculty begin to regard instructional technology as something that is someone else's job in someone else's course. For this reason, we believe that faculty inservice should be considered a critical part of the role of information technology specialists in colleges of education.
4. The final cause is probably the most important and will certainly be the most difficult to eliminate. One of the most important reasons that integration in teacher education has been slow is that teaching practices and the very concepts of teaching and learning are not consistent with the use of information technology. This, we believe, is a powerful reason why interactive multimedia has had so little impact on teaching at all levels. (There are other reasons of course, including antiquated hardware, scarcity of high-quality material consistent with the curriculum, lack of expertise, high cost, etc.). Interactive multimedia is designed for individual use, and although teachers at all levels pay lip service to individualization of instruction, most instruction in our schools is large-group-oriented. Interactive multimedia is not suited for use by groups (even small groups), and may therefore remain a little-used educational application.

Changing the orientation of schooling at the university from large group to individual or small group will be even more difficult than achieving this change in public schools. In truth, it is probably unrealistic to envision such a change at any level. However, unlike commercial interactive multimedia packages, the Internet (although it contains some interactive programs) can be used in group settings, especially small-group settings, and such uses should be emphasized when conducting inservice workshops for teacher education faculty.

The above problems are difficult barriers to productive use of the Internet at all levels. They are not insoluble, however, and we believe that we have a tool at our disposable that goes a long way in answering critics who cite one or more of them. That tool is the hands-on Internet demonstration or workshop. We have found that virtually everyone is enthusiastic about school access if they are given a competent demonstration of the Internet involving a connection and software and hardware that permits full graphics, sound, and animation. The Internet is such a unique and powerful computer innovation that almost everyone immediately sees the possibility for new educational practices and paradigms.

It is not often that a new educational tool "sells itself" so widely and so persuasively. We should take advantage of this unique characteristic while emphasizing the problems listed above are in need of solution. In so doing, we may yet bring this amazing and potentially revolutionary teaching and learning aid to teachers and students at all levels, and avoid the disillusionment and abandonment that has marked past efforts to integrate electronic technology into education.

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The Teacher's Ultimate Classroom Resources: *Mosaic* and the World Wide Web

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Recent developments in technology have created an unparalleled opportunity for significant change in education. Two powerful instructional tools, telecommunications and hypermedia, have suddenly converged to form a new and dynamic way to facilitate the transfer of knowledge in today's classrooms. The elements behind this new higher-order platform for learning are principally derived from a special segment of the Internet called the World Wide Web, and a "browsing" program needed to read the documents transmitted across this medium. Currently, the most popular of these programs is called *Mosaic*.

The World Wide Web and the Internet

The Internet, popularly known as the Information Superhighway, is a collection of interconnected computer networks that business, education, government, and now the general public use for knowledge exchange. Its use is expanding rapidly. The Internet has grown by 81 percent in the last year alone and although difficult to determine accurately, it is estimated that there are over 30 million world-wide users on the Internet (Schwartz, 1994). The World Wide Web is a special segment of the Internet that supports the transfer of documents containing text, graphics, sound, and full motion video. It was developed by the European Laboratory for Particle Physics (known by its French initials, CERN) in Switzerland. It uses client/server architecture and was designed to be compatible with all types of hardware and software platforms found on the Internet. Initially launched in 1991 as a way for international physicists to exchange information, the global implications of this new technology quickly became obvious to the Internet community. The infrastructure supporting its evolution has been growing rapidly ever since.

Accessing the World Wide Web — Requirements

Requirements for World Wide Web interaction include a computer — Macintosh, Windows, or X Windows — configured at current specifications, and Internet access. Of particular importance to K-12 education is the fact that an acceptable level of performance can be achieved with a hi-speed modem over a standard dial-up phone line. Local Internet access providers and other communication companies are now making the Internet available over standard phone lines at reasonable and easily affordable rates. Of course a direct Internet connection found at most universities typically supports much faster transmission speed and is therefore more desirable.

The second major component in this process involves a program that reads or "views" World Wide Web (known as Web or WWW) documents. The most popular of these viewing programs is *Mosaic* and its derivative, *Netscape*. The original *Mosaic* program was created by the National Supercomputing Center (NCSA) at the University of Illinois and introduced in late 1993. (*Netscape* is recently released by a commercial venture partly owned by one of *Mosaic's* original developers; it has attracted widespread attention and is very popular as of this writing). A significant factor is that these programs and other support software are distributed *free* at this time. Widely used Internet protocols and tools are compatible with the World Wide Web and are becoming integrated into the latest iterations of *Mosaic*. The end result is that a common graphical interface is emerging which makes World Wide Web resources as well as all other Internet resources seamlessly accessible and easy to use.

Web Servers

So far, only the user or "client" side of the World Wide Web has been addressed. The other part of this distribution system is repositing Web documents on powerful computers connected to the Internet and "serving" them to clients upon request. These special computers are called Web servers and require more sophisticated technical knowledge to set up and maintain. Although this is a more challenging path for any educational institution —particularly K-12— to embark upon, schools, assisted by universities and government entities, are beginning to establish and maintain their own Web servers. Web server access or ownership would hopefully be part of any early adoption of this technology by a school. This is absolutely essential as teachers and students begin to create their own Web documents and make them available to the educational Web community.

Educational Implications

The overwhelming significance of using the World Wide Web is its inherent synthesis of so many powerful instructional elements. They are fundamentally embedded in the Web framework. Singularly used in the past and identified as important instructional features in their own right, they include telecommunications, hypermedia, and application authoring. All involve interactive engagement on the part of the learner and require the acquisition of technical and cognitive skills that are absolutely essential for life long learning and future success. In a way that implies both the criticality of our present condition and a solution, Lewis Perelman in his compelling book, *School's Out* cogently makes the following observation:

> With knowledge doubling every year or so, 'expertise' now has a shelf life measured in days; everyone must be both learner and teacher, and the sheer challenge of learning can be managed only through a globe-girdling network that links all minds and all knowledge (Perelman, 1991, p. 24).

The above statement is a powerful one. An understanding of knowledge distribution systems like the World Wide Web will be absolutely essential for both personal and societal growth and development. Until very recently, Internet activities were arcane, research oriented, restrictive, expensive, and principally text based. With the advent of the World Wide Web, it is now much easier to access and use for many purposes including general instruction.

Active Engagement of Teachers and Students

The epistemological notion behind Piaget's constructivism (London, 1988) is that learning and thinking intimately involve the participation of the learner. You learn by doing. To learn something, is to see it, modify it, change it, and transform it. A computer works very well in this model because activity is inherent in its use — you must interact with a computer to get it to do anything! The amplitude of this process is greatly increased when a multimedia computer is used. Adding visual, tactile, and audible elements in an interactive way cognitively enriches the experiential nature of the learning. It increases further when you include the potential for collaborative learning over a knowledge based distribution system like the Web. Addressing the visual acumen of today's students, Larry Smarr, director of the National Center for Supercomputing Applications at the University of Illinois makes this statement:

> The eye-brain system is incredibly advanced. Looking at the world, we absorb the equivalent of a billion bits of information per second, as much as the text in 1,000 copies of a magazine. But our mental 'text computer' is limited by the fact that we can read only about 100 bytes or characters per second (Smarr's quotation cited in Helsel, 1993, p. 83).

Ellen Notar (Notar, 1989, p. 67) states this same idea more viscerally: "Imagery rides directly into our brains."

Mosaic uses a point-and-click interface and common menuing system familiar to computer-using teachers and students. Its hypermedia properties allow users to move quickly from one topic to another. With a click on a highlighted word, phrase, or image, a student can jump to a related photograph, sound, or full motion video clip on another computer on the other side of the world. In Figure 1, two sessions of Mosaic are on the same screen.

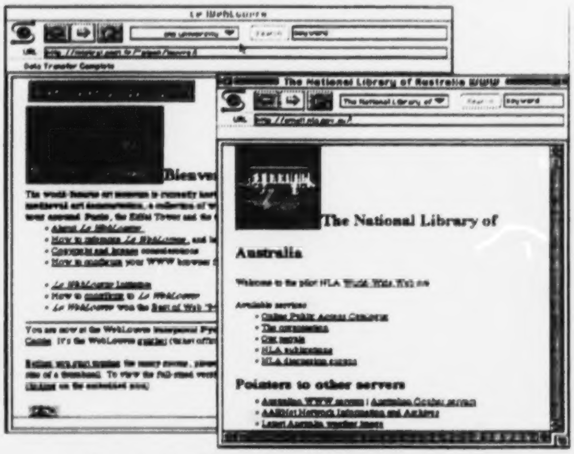
Data Transfer Complete
The National Library of Australia WWW
Bienve
The National Library of Australia
Pointers to other servers

Figure 1. Browsing Web Resources (http://mistral.enst.fr/~pioch/louvre/ & http://email.nla.gov.au/).

The upper left window preludes a "visit" to The Louvre's Web document. In the lower right window the viewer is at the steps of The National Library of Australia. Both museums are electronically linked to the computer desktop; the student can browse these "virtual" museums practically at the same time. Anyone who appreciates the pursuit of knowledge can immediately see the implications for learning in this kind of scenario.

BEST COPY AVAILABLE

Creating Knowledge Based Documents

Internet and World Wide Web access are rapidly becoming available to schools. Authoring tools (sufficiently powerful computers, modems, scanners, sound and video capture boards, etc.) are also becoming more prevalent. World Wide Web documents are based on an amazingly simple language called hypertext markup language (HTML). It can be written with any ASCII text editor commonly found on most computers. The authorial efforts of teachers and students can stimulate a high degree of creativity and involvement. Teachers and students can easily learn to construct their own instructional documents and leverage their knowledge content by linking them to other resources on the Internet.

Instructional materials used successfully in the classroom can serve as an excellent starting point. For example, Figure 2 shows a Web document based on classroom instructional materials developed by the Virginia Marine Science Museum, Virginia Beach, Virginia. The noted link is made to another WEB document that provides related information. It was constructed by a group of teachers (Barnhardt, Joyce, Mierzwa, Phipps, Snyder, 1994) for use in a K—5 classroom. It is easy to place links within a document to include existing Web documents or other Internet functions which support and enrich the main document's instructional objectives. The notion of scalability becomes operative in this kind of learning environment. Students can participate within the Web framework at whatever level of knowledge their expertise and interest allows. For example middle school students can "sit in" on the discourse of world researchers exchanging information on a topic of critical importance. The students may even be able to participate if their interest and level of expertise match the participating group. On the other hand, additional resources addressing student weaknesses can easily be linked to provide a remedial path for the student who needs this course of action. This easy connectivity of instructional elements and learning scalability provides a kind of instructional gestalt never seen before in any learning environment.

Conclusion

The idea of exploring knowledge stored within the World Wide Web is very enticing to teachers and students. The more powerful dynamic in this process, however, is how it can increase intrinsic motivation by actively engaging and encouraging students to take ownership of their own learning. In an environment where the teacher serves as a model and guide, students can easily use documents to build and extend their own knowledge bases. Cooperative projects within the physical classroom and beyond it, encourage a prosocial aspect not possible in other settings.

Most teachers and students typically want to display and share their best work. With Mosaic and the World Wide Web, the best lesson plans, activities, student projects and any other educationally relevant information can be linked and shared across the Internet. In this respect the classroom truly becomes global in scope and learning becomes an ongoing and self-invoking process for the student.

File Edit Options Navigate Annotate
Starting Points Personal
Help

Figure 2. Examples of Mosaic Instructional Documents (http://curry.edschool.virginia.edu:/~rwg8y/vmsm0.html & http://curry.edschool.virginia.edu/~kpj5e/Project.html).

Providing access to the Internet and promoting skills acquisition of global knowledge tools like Mosaic and the World Wide Web can fundamentally shift knowledge transfer to a new level. This kind of instructional environment encourages unencumbered exploration and self-discovery and promotes a sense of intrinsic motivation to learn — critical elements for lifelong learning. We, as educators, must look closely at embracing this new instructional paradigm for the classroom. The seeds of tomorrow's survival skills are contained within it.

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Multimedia Telecommunications: Services for Professional Development

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The concept of an information superhighway suggests that professional development will be available at any time or place to suit a client. However the current wealth of information to search will need to be balanced by two-way communications to extend and enhance professional skills. This paper describes services being developed through the Multimedia Communications Brokerage of the University of Exeter in the UK. The University has been developing such exemplar services as ISDN, point to point communication channels. Services currently under development include:

- Navigating the Internet for schools
- Cell Biology at the ultrastructural level
- Geology in the South-West of England

The concept of a Brokerage is complimentary, permitting further spread of expertise by building up the portfolio of services and larger, overlapping client groups. The brokerage develops both the services and the market itself by bringing new providers and their clients online. One example is the Psychometric service offered by Weymouth Flexible Learning Center, due to the training and support efforts of Exeter. This project is being extended to SuperJANET, the UK wide band academic network and forerunner of the world Information Superhighway.

Emerging communications technologies enable specialist expertise and resources to be delivered from a distance and thus increase the range and quality of teaching and research available within an institution. The consequences of this are likely to have a profound effect upon all teaching and learning in the near future. A developing role for educators in the university sector is in the provision of services via the "Information Superhighway" based on their various expertise.

In order to harness the power of burgeoning communications in a way that will provide an effective service to education, effective piloting and evaluation of the learning experiences must be carried out. This paper describes services under development in the University of Exeter in the UK. Two main projects are involved in this. The Multimedia Communications Brokerage (MCB) is funded by the Department for Employment to create services and test the concept of a brokerage. The New Technologies Initiative project, funded by Joint Information Systems Committee, will test the feasibility of remote team teaching between universities over SuperJANET. The production of multimedia resources requires a range of skills and knowledge not often found within one institution. Partnerships between two universities can benefit the teaching and research of both institutions complementing the skills and expertise across to the benefit of two cohorts of students. Multimedia communications can provide:

1. curriculum development and specialist teaching
2. professional development for senior staff
3. mediated review of new software and multimedia products
4. access to a consultant

At the same time the projects are developing information and advice on the adoption of multimedia communications themselves. Information is being published on the adoption and integration of the appropriate multimedia technology to match the user's needs. A complimentary distributed network of informed, experienced and active practitioners in the educational multimedia field is also evolving in the UK.

The Brokerage

The first cases in the applications of ISDN in education were described in Davis (1992). At that time the focus was on integrating remote teaching, including student teacher teaching, into the curriculum of secondary schools. A cost benefit analysis showed that the schools most valued the professional development for a wide range of staff: support staff, teachers, and senior managers. However, it proved difficult to provide a wide range of activities for the schools. The limitation was the range of expertise within one University which matched the needs of the schools. The concept of a brokerage was born of this realization. There was a need for both new services, new clients, and a brokerage could build and support new partnerships. The brokerage stimulates the market and provides support for the development of new services and service providers. The service providers also enlarge the market by advising their clients of the services and new modes of professional development available using multimedia communications.

The work reported here retains the high quality sound and images possible using DeskTop Conferencing, rather than the more common video conferencing. The maximum transmission of the high resolution images currently is one per second and so the project is focusing on still rather than moving images.

The Services

The following section describes some of the services under development.

An Educational Guide to the Internet

Increasing access to the international electronic communications networks (the Internet) offers many possibilities to schools. In the UK, educational use of the Internet has been largely restricted to Universities. Potential access is increasing with new services. The installation of Cable TV networks is increasing free local call access. Large volumes of information are available in three main forms:

1. bibliographic searching
2. text and multimedia collections
3. discussion groups

Such access is revolutionary because the end-user has efficiently been moved from a dependence solely on locally based resources to a world wide availability of resources. This is vitally important in supporting research, and hence facilitating the concept of research supporting teaching. In the UK, early use of systems such as Bulletin Board for Libraries (BUBL) and National Information Services and Systems (NISS) have made access very simple. Gopher and World Wide Web have also come into general use.

In addition to an overview of the vast sea of files available across the world, the School of Education librarian's Internet service demonstrates Exeter's WWW server which provides local information. Recent funding has been set aside for production of resources designed for remote use by University of Exeter students on school-based programs. Discussion groups also abound. Local news groups are being developed in conjunction with electronic mail to support communications between student teachers and their tutors and to run remote seminar discussions.

Cell Biology and Electron Micrograph Interpretation for Biology

Visual images are fundamentally important in the study of biology. Students' understanding of biological processes requires observation and interpretation of suboptical structures and their related functions. Transmission electron microscopes (TEM) can resolve images about 200 times better than the best light microscopes because they use the far shorter wavelength of an electron beam focused through the specimen by electromagnets. Images such as these require a very high degree of expertise to capture and to interpret, but they are very important in the study of biology from school level upwards. A mediation service was therefore developed.

DeskTop Computer (DTC) conferencing between advanced school biology students and a university tutor with expertise in electron microscopy provides a service of intensive tutorials using first hand micrographic material with guided interpretation The DTC software permits students to interact with the image, under the clear guiding voice of the university tutor. .This both facilitated understanding and provided access to fresh high quality resources. The aim of the service is twofold:

1. To provide an introduction to the interpretation of electron micrographs.
2. To provide further support for students' understanding of cell ultrastructure and physiology, using the reproductive system as illustration.

The reproductive revolution is rarely out of the headlines. The attempts of the scientific community to control human fertility and to alleviate human infertility are seen as among the most important endeavors of late twentieth century biomedical research. Recent enlightenment has come about as a result of an increase in our understanding of the structure and function of the gametes (sperm and eggs) and their supporting tissues at the cellular and molecular levels. More basically, the significance of reproduction as the single most distinguishing characteristic of life is reflected in the relative importance placed upon it in school biology syllabuses.

High quality electron micrographs of gametes and reproductive tissues were transferred onto PhotoCD, and image management software has been used to display and manipulate these images during the conferencing link. The relevant sections of the school syllabus were addressed and enhanced using these materials. Students were given a follow-up exercise to test their understanding of the subject matter and they were also invited to give their comments about the learning experience. This data is now being analyzed. Further detail is provided in Baggott and Wright (in press).

Basic Concepts in Geology

Geology in the secondary school curriculum has been problematic for over a century in the UK, mainly because of its overlap in the differing curricular areas of Geography and Science. One consequence of this is that knowledge and understanding of basic geological concepts is not widely spread within society at large, and this includes teachers and hence pupils in schools. For example, the most fundamental concept, that of geological time is poorly understood generally. This service provides a direct learning experience for 14-16 year old pupils, by expert teaching using images in a DTC link with pupils in schools.

The service was developed as a sequence of one-hour sessions for 14 year olds on basic geological concepts, using images drawn from a large image database. The subject of local rocks involves the generation of an in-depth discussion with school students about the origin of the rocks and more significantly, possible time scales involved. The learning activity was centered upon the cyclic process of observation, description (articulation), questioning and selection (i.e. of additional images relevant to the question). The ideas of "deep time" and palaeogeography were introduced in this session, and pupils were encouraged to hypothesize about geological phenomena. Subsequent sessions dealt in a similar way with increasingly complex ideas, but within the definition of "basic geology" in the British National Curriculum.

The DTC teaching was supported by giving students access to geological specimens, which were sent on to the school in advance. The images used in the service included color pictures of rock exposures, general landscapes, building materials, and individual specimens, such as fossils. Diagrams and sketches were also employed, and students assisted to annotate and modify images on the screen. These features make this an adaptable and flexible learning mode, which can easily be made relevant to a range of abilities, experiences and locations of students.

CD ROM Evaluation Service

One fundamental problem with purchasing educational materials that cannot be first obtained on an approval basis is that of assessing the quality and suitability of the products. This is particularly true in the case of CD ROMs. Because the profit margin is so small, it is not economical to send a representative or salesman to remote locations to demonstrate the materials. The relative cheapness of some of these products is an important marketing factor, and one way round the demonstration problem is to offer an evaluation service through DTC. A piece of peripheral hardware enabling this is a quad-speed CD ROM jukebox (Pioneer 604X) which gives very good representation of the multimedia resources. The customer phones through on the ISDN line to inspect the goods. An advisory discussion can lead to an interactive demonstration of the CD ROMs which interest the buyer, who can then be handed the keyboard and left to "play." Questions can be answered, thereby helping the customer to make an informed decision. Costing for the advice and prevention of piracy are issues currently under consideration before the evaluation service is launched commercially.

Multimedia Staff Development

Team teaching and remote staff development in the applications of multimedia resources is another example of the appropriate utilization of University expertise. Initial training days in situ may be followed up by online sessions working with small groups or individuals who are developing their own use of IT. Success of this 'service' is more dependent upon commitment from the institution in terms of resources required, for example, providing resources to free members of staff to work on the project. However, it is hoped that as the potential for producing high quality teaching materials which are also precisely suited to the teachers' requirements are realized, this service will become increasingly popular.

Conclusions

The world of education is being transformed by the development of communications networks which offer users at remote locations access to learning materials held on a central computer. These projects have been made available through broad band communications. Point to point services can be developed to address the needs of small groups and individuals in education. The brokerage concept can extend these services across new service providers and their client groups. The initiative, based at the University of Exeter, has encompassed the world of both education and business, with educational participants providing expertise in an expanding range of subjects.

Multimedia communication has enormous potential for enriching and extending current educational practices within higher education itself, but has yet to make its full impact on the majority of courses and students. The existence of a knowledge base within this field does exist, but different components are located within key individuals at a variety of institutions. The scattered location of leading edge knowledge and practical expertise can be partially overcome by the adoption of new communications technologies. The "Information Superhighway" in itself however, provides no more than a means of communication to remote sources of information which can add to an academic's current overload. Online partnerships can instead share and expand the expertise available.

Acknowledgments

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Creating Listserv Lists for Teacher Education Enhancement

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Teacher education, by definition, is a program of study designed to prepare future teachers, and to provide opportunities for current teachers to gain new skills and knowledge—all with the end goal of preparing teachers to provide the best education possible for today's youth. Educators around the state, the nation, and even the world, face and conquer similar problems, while experiencing the joys that accompany lessons well-taught and well-learned. Teacher education programs should provide students with skills and opportunities that will allow these teachers to communicate and exchange information with their fellow educators around the globe.

Many teachers, especially new ones, feel that their classroom troubles are unique, and struggle to find their own solutions, unaware that there is a vast network of fellow educators available to listen, provide suggestions, and discuss their own solutions for similar problems. This network is available on the Internet, and is comprised of a large number of electronic mailing lists, where educators (and others) may read, ask questions, and/or offer suggestions to their colleagues around the world.

Teacher education students, both undergraduate and graduate, should be exposed to these invaluable resources throughout their programs. However, this need not be limited to the existing lists. Establishment of a class list allows students to develop list participation skills, while providing a forum for class discussions and other activities. A list may also be established to extend the classroom experience, to provide support for students after they have completed their course work. Lists may be established to promote research in an area, or to provide a forum to lessen the feeling of isolation that former students may feel.

Listserv Lists

Listserv lists (discussion groups) use computer-mediated communication (communication through the medium of the computer) to allow educators and researchers to enter into subject or discipline specific communication with an international array of colleagues who would not be readily accessible through traditional means. These lists act as forums for the sharing of information, research methodology and findings, rare sources and documents, and advice.

What is a Listserv?

Listserv is a type of software that runs on mainframe computers, and automates many of the tasks associated with running a list. Diane and Michael Kovacs (1994) provide an excellent discussion about using Listserv software to establish and maintain lists. An earlier version (Kovacs, McCarty, & Kovacs, 1991), is also available online at a variety of locations. Listserv software allows list owners/moderators to customize each list by determining the level of control and automation for each list, and by regulating the type and content of automatic messages. The mechanics of list operation are largely transparent to the user, who need not understand differences between an open and closed list, between a moderated and unmoderated list, or other technical details. Necessary information can be included in the individual list instructions, frequently asked questions , and communications by the list owner/moderator.

Advantages of Using Listserv

Listserv lists provide an easy way for many people (generally of similar interests) to receive messages from all other members of the group, and to respond to those messages, if desired. Although thousands of lists exist, new lists are appearing daily, as a needs are perceived.

Owning and moderating a list has hitherto been an educational training and research tool, often relegated to computer experts. However, there appears to be a growing number of lists created for university classes and other such specialized groups, with list administration not always restricted to the *computer guru*. Typically, competence as a list moderator is gained by trial and error. However, several lists have been established to provide assistance for new and experienced listowners; LSTOWN-L@SEARN.SUNET.SE is an excellent resource, where new and experienced list owners trade questions and answers. (Subscribe by sending an e-mail message to LISTSERV@SEARN.SUNET.SE with the message *subscribe LSTOWN-L YourFirstName YouLastName*.)

Help with Listserv

Help (in addition to the LSTOWN-L list) is available for anyone wishing to learn about Listserv. List subscribers might appreciate the command list available by sending the message *help* to any LISTSERV. See Figure 1.

An *INFO REFCARD* request will provide a list and syntax of beginning through advanced commands, and can provide material for further study.

Header Commands

Examination of the header which defines the operating characteristics of any list, provides some basic information about list parameters. The header may be obtained by sending the message *review ListName* to the appropriate Listserv address. Following is a description of some of the basic commands or parameters found in Listserv headers.

Subscription. This indicates whether subscription is open to all *(Open)*, or is closed *(By_Owner)*, meaning that the list moderator must approve each subscription request.

Review. If this is set to *Public*, anyone can obtain a list of all list subscribers and their e-mail address. If it is set to *Private*, only list members can obtain this, and if it is set to *Owner*, only the owner can do so.

Notebook. This indicates whether archives of all messages sent to the list are maintained, and whether anyone (default) or members only (*Private*) can access these.

Confidential. If this is set to No, the list name and address will be included in the global list of lists (available by sending the message *list global* to a Listserv—but be aware that this is a very large file). If it is set to *Yes*, it will not be included in the global list. This is helpful for lists that are restricted to class members or some other such limited group, for it will hide the list from the rest of the world. Otherwise, you may receive subscription requests from around the world.

List Moderation

Duties of list moderators vary, depending on the purpose of the list and the desires of the moderator. Unmoderated lists allow open subscription, and provide for messages to go directly to the list for distribution. This requires the least amount of maintenance, and necessary duties are performed by the listowner. In a fully moderated list, all subscription requests and messages to be sent to the list must be approved by the moderator. The amount of time this takes depends on the size of the membership as well as the amount of message traffic. Moderators choose the desired level of control, along a continuum between the two extremes described above.

List moderation does not require any special account. Activities can be completed either interactively through an account on the same system as the Listserv, or through e-mail. There are advantages and disadvantages to each, and the computer system administrator can assist with the decision and the account set-up. Connections may be through either direct or dial-up access, and the communication package of choice may be used. Use of a flexible, familiar environment may provide comfort and a reduced learning curve for new list moderators. It is essential to remember that the amount of time required for list moderation is in direct proportion to the parameters that have been established for that list, and this is within the control of the list moderator. The parameters can (and should) be changed as needed to meet the changing needs of the subscribers and the moderator.

Examples of Lists

As mentioned earlier, one of the advantages of Listserv is the ability to customize lists (using the above options and others), according to the specific needs of each. The following lists, operated by the authors, are presented as examples of lists that could be used in teacher education and related areas. The administrative address for each is LISTSERV@ETSUADMN.ETSU.EDU.

Lists for University Classes: ETEC524, ETEC625, ETEC626

These lists are used in three graduate educational computing classes, where all students are required to subscribe to the appropriate list. Subscription is by owner, and review is also private. Archives (notebook) are maintained, but are set to private, and lists are set to confidential. Activities on each list differ, according to class. ETEC524 serves an introductory course, where some students have had little or no experience with computers. The accompanying ETEC524 list activities begin with personal introductions, and a sharing of some assignments with classmates. On the ETEC626 list, students submit assignments, but they also may send items that might interest their classmates. Each of these lists has very light traffic—an average of one or two messages per day. ETEC625, however, is a high traffic list, since the Internet is the focus of the class. Messages average about six per day, consisting of assignments, requests for assistance, as well as a sharing of new knowledge and exciting finds. Students also use the LISTSERV DATABASE function to access the list archives.

These lists are used as integral parts of each class. To facilitate this, heavy emphasis is placed on appropriate list netiquette. Students learn to send administrative requests to Listserv, class messages to the list address, and personal messages off-list.

For Extension of These Classes: ETECESP

ETECESP (Educational Computing at East Texas State University List) is an unmoderated list is for current and former students in graduate educational computing classes, as well as for anyone else who wishes to join. Review, posting to the list, and archives are private, but confidential is set to no. The list is used for dissemination and discussion of information about educational computing , with an emphasis on K-12 issues. Former students often participate in discussions from current classes, and items of interest are forwarded by subscribers as well as the listowner. An unexpected effect of the ETECESP list (for the Internet course) is a lowering of volume (and contributions) on ETECESP. The more vocal ETECESP subscribers were sending all of their contributions to the ETEC625 class list (since they were taking the class).

Although this is an unmoderated list, it is necessary to watch the list contributions and be prepared to send off-list messages to individuals who post off-topic or have other problems. When establishing any list, it is important to be aware of how the new list may affect existing lists, and whether any problems will be caused.

For Research: HMEDRSCH

Students who have successful list participation experiences may wish to start their own lists. The Home Education Research List is an example, for the moderator participated in ETECESP (as a student), realized the value and power of a list, and HMEDRSCH resulted.

HMEDRSCH (Home Education Research List) is a moderated list and was established to fulfill a perceived void in both educational research discussion lists and home education discussion lists. Home Education Research is a moderated discussion list for scholars, researchers, and others professionally interested in the area of home education. The list is dedicated to scholars, doctoral students, or people that are consultants to home educators and provides an avenue through which research material and pertinent information can be distributed. The HMEDRSCH list was set up so that everything is privatized as much as possible. Those who subscribe must establish a legitimate reason via the moderator. Messages must also be approved by the moderator. This is a very low traffic list as a scholarly list, persons post requests to the list, and then pursue private, off-list, follow-up discussions. This is an example of how lists have individual personalities, and this results from the subscribers, as well as the style of the moderator.

For Other Purposes

Among the other lists operating on the same listserv, are confidential departmental, committee and other lists. These facilitate communication, and are introduce some people to their first list experiences. Traffic on these fluctuates, and is often light. Another list, for members of the Doctoral Students Association, appears to be helping people compensate for the feelings of isolation (due to geography as well as class situations), and to promote a sense of community among the members of the organization.

Helpful Hints

The lists above have all made positive contributions to the associated classes and subscribers. Operation of these lists has led to the following suggestions that might help other educators who wish to set up similar lists.

1. Before beginning, make friends with your Computing Center staff, and especially with the system operator. This will be invaluable.
2. Carefully consider the list parameters, and how you will set the header items.
3. Thoroughly consider the clientele your list will serve, including their levels of computer expertise, and the list's obligation to its subscribers; what type of postings will be appropriate, and how much involvement will the moderator have?
4. Test the list with volunteers for a couple of weeks before announcing the list's existence.
5. If subscription is not open, anticipate and prepare for subscription requests from ineligible individuals. Decide whether to ignore these or to prepare a form letter of explanation
6. If you are establishing a class list, subscribe from any and all accounts you may need to use.
7. Remind subscribers to unsubscribe from an old address, before signing on with new one (if applicable). This may be necessary if students use class accounts, and then wish to continue subscription after the class has ended.
8. Do not over-advertise, if list subscription is limited. If subscription is not open, advertise only to the eligible potential subscribers.
9. Do not establish a preconceived notion of who will be on the list and the list's level or type of activity. Be flexible.

Conclusion

When there is a need to communicate, setting up a LISTSERV list is a viable option. With the proper support and preparation, it is relatively easy to moderate such a list, and the benefits can be tremendous.

Establishing and using LISTSERV lists in teacher education will prepare future and current teachers to be active information seekers and disseminators, as they meet and join colleagues around the world in dialogs on these lists. As they and their students participate in such exchanges, multicultural understanding will hopefully increase, as the world comes into our classrooms, via the Internet and these LISTSERV lists.

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Telecommunication Projects Designed for Preservice Students

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Project One: Preservice Telecommunications

A required course, "Technology in the Classroom," is taken by all elementary and special education students before student teaching and provides an overview of technology integration. One hundred and eighty students are enrolled each semester in 9 lab sections of 20 students each feeding into 5 lecture sections of 20-40 students. A telecommunications component was added Spring 1993, with an emphasis on electronic mail. Students are introduced to a university UNIX system supporting electronic mail and access to the Internet.

Students use electronic mail to communicate with a student partner and with instructors, but e-mail is also used as a vehicle for introducing K-12 telecommunications projects. Originally, students were required to log in to their account and to send at least one mail message to their instructor per week. This practice became cumbersome for instructors, especially when many messages were of the "Hi, hope you have a nice weekend!" variety. To provide more structure, the once a week message was changed to an activity to be completed approximately every two weeks. The first activity is a poem following a specified pattern. Students have to read and print out the project guidelines, create a new message to their instructor, carbon copy to themselves, and then write a poem following the prescription. Throughout the semester, feedback on the course is solicited via electronic mail. This format has encouraged instructor refinement of content and process each semester.

Informal student evaluations are solicited several times during a semester. An online assignment has included such questions as: "Reflect on the activities used in this course so far. What one activity would you advise your instructor to include in next semester's course and why would you keep it?" "What activity would you suggest we throw out next semester, and why?" "What do you wish you would have done differently this semester?" "What one characteristic stands out in your instructor's teaching?" and "What one characteristic would you suggest she work on to improve her teaching?" This obviously requires some risk taking on the instructor's part, but feedback from students (usually online) has been overwhelmingly positive. Student comments have included: "This is the first time I've taken a class where I have been included in the development of curriculum, and where my suggestions count." Comments such as "I wish you wouldn't talk so fast—I know you have a lot you want to cover, but there is so much information and it comes at us so fast that I just zone out." and "Could you not tell such long stories? The stories are usually good, but it takes you so long to get to the point." have been an effective mechanism to improve teaching immediately, rather than waiting half a semester later to read student comments.

Electronic mail has been an effective way to share information pertaining to course content. Classroom projects from an instructor's Listservs are distributed frequently to all students for a telecommunications portfolio. Many students react to the telecommunications projects shared or ask questions about class lectures and assignments. All mail presently is private, and there is no conferencing component. When a particularly interesting or pertinent question is asked, that all students might benefit from, the question and answer are distributed to the entire class.

Several semesters have included partnering with a high school in Texas and with a teacher education program at a university in the state of Washington. High school students and several teachers from Texas were paired with NAU students for one semester. There was no focus given for messages, so students began with the typical "getting to know you" kind of introductions. This project became cumbersome for the teacher facilitator in Texas—he was using one computer in the media center with his personal userID, so in most cases, he had to download and print each message, distribute them to the 50 student and teacher participants, and then find time for his students to write messages back. NAU students had easy access to computers and wrote frequently, causing a backlog of work for a once enthusiastic teacher, while the high school students could not get access often enough to befit their NAU partners. This became a real-life lesson in e-mail access.

A second partnering project paired volunteer NAU students with preservice students at another institution, both taking an educational technology course simultaneously. NAU students choosing to participate for a final project were required to go beyond "getting to know you" to make a connection to K-8 classrooms. Most students planned to explore how the two schools of education compared, with several students planning to complete a telecommunications lesson plan that could connect both teachers' future classrooms. Because the project was required for a grade for participating NAU students and not by their partners, approximately two-thirds of the participants ended up having to change their final project at the last minute because they were not getting the kind of dialogue they felt was needed to complete a major project. While students expressed disappointment, many also expressed that they understood what younger children would feel like if a partner didn't write to them during classroom penpal exchanges. The project will be available to future students, but dialogues will take place with the university instructors from both locations to develop guidelines for future participants.

Many students choose an Internet-related component for their final project. Typically, this involves exploration of gophers, the World Wide Web, and subscription to a Listserv. This has probably been the most difficult telecommunications feature to take care of in a required preservice course that tries to meet the needs of preservice teachers before they hit the classrooms—everything a teacher needs to know about technology and technology integration in one short semester. Students rely on campus library orientations to get them started, books and articles on reserve for a graduate online course on telecommunications, and private e-mail with their instructor.

There have been several benefits of electronic mail pointed out by NAU educational technology faculty in the past year. Student and faculty feedback has indicated an increased use of reflective communication on the part of students, as well as fewer problems with misunderstood assignments, clarifications, and elaborations of course content. Students who choose to access the Internet for their final project typically leave the course with a beginning knowledge of information resources available on the Internet, and most education students are able to show awareness in infusing online information sources or projects to curriculum. It seems to make sense that if students are introduced to electronic mail and the Internet early in their program, all courses taken in the semesters following would benefit from student knowledge of resources available to them. Discussions are in progress by CEE curriculum and instruction faculty on when students should take "Technology in the Classroom."

Project Two: Preservice/Inservice Science Partnering Project

Student teachers have reported that during their student teaching experience, they were ready to integrate technology into their instruction but many of their classrooms were not equipped to support technology and/or cooperating teachers did not have enough knowledge to provide technology support. Several years ago, the Arizona Department of Education put into place an educational network supported by GINA (Graphical Interface Network Access) software, software developed and used in California. This network is affordable, at $22.50 per userID per year, and supports an 800 phone line. The graphical interface is user friendly and provides access to electronic mail, information sources through the Internet, and electronic conferences. There are few long distance lines into the state server, and with increased use, access is limited. It is the only resource available, however, to provide a K-12 connection other than subscription services.

A pilot project consisting of 20 preservice teachers taking a science methods course and a technology in the classroom course during a back-to-back block of time are paired with 20 teachers learning to use the Internet for science teaching and learning. Teachers of science from 3 school districts in northern Arizona, (city, rural, and Navajo Reservation) were introduced to telecommunications through a course sponsored by an Arizona Eisenhower grant during the Fall 1994 semester. Spring 1995, students and teachers are paired at weekend seminars taught by technology and science content faculty at the university. NAU students accompany university participants (science content, technology, and graduate assistant) on site visits for observations first, and then for team teaching opportunities. All participants are connected via the statewide electronic mail network with access to the Internet. Students will student teach Fall 1995 with their science teaching partners. It is projected that this network will be increased by 40 participants each year for the next two years, bringing together an online community of teachers of science that will number 120 by Spring 1997.

Teacher participants in this project are located in K-8 classrooms in three diverse settings: Flagstaff, Williams, and Kayenta.

A Visit to Participant Schools

Kayenta School District. Kayenta, a school on the Navajo Indian Reservation, is 180 miles from the mountain town of Flagstaff, the nearest large city. Two teachers from Kayenta Middle School and two from the intermediate school are already collaborators as they use their linked technology-rich classrooms to share instruction and learning opportunities. Two television monitors with video cameras mounted above them display a busy middle school classroom of students working on a project in the intermediate building. Both classrooms are supplied with 16 networked Macintosh computers and a dedicated phone line. A nearby computer lab reveals a classroom of what could be 75 Macintosh computers, multimedia stations, and laser printers. A primary teacher in this district has not fared as well, and for part of the project had to make arrangements with the office secretary to use a phone line. A dedicated line will be installed before the end of the Fall 1994 semester. Five Kayenta teachers drive to the NAU campus once a month for a Friday evening, all day Saturday seminar on using the Internet for science teaching and learning. There, they are joined by ten teachers from local Flagstaff elementary and middle schools, and by five teachers from nearby Williams.

Williams School District. Williams is a small town located about 30 miles from Flagstaff, and is known for its hospitality to tourists around the world who approach the Grand Canyon by steam engine train. It is a quiet community where one might find themselves the only English speaker in one of the town's many restaurants. The quiet is broken several times a day as the whistle blows to signal the trains' comings or goings. On one visit to the Williams Elementary and Middle School, a Hollywood film crew was packing up after filming a movie using this historic town as a set for a western. The school looks like most schools, except there is an audible buzz. The community has just passed a bond referendum which includes a technology bond for new computers and phone lines into each classroom, with installation completed by Thanksgiving, 1994. Teachers in the NAU project know they will have connections to the Internet and e-mail soon, but are frustrated that they have not been able to gain access during the first semester of the project and must go 4 weeks between e-mail checks.

Flagstaff School District. With three high schools, two middle schools, and twelve elementary schools, Flagstaff is the largest school participating in this particular project. Teachers were self-selected and five of the ten Flagstaff participants are from one elementary school. The buzz is quite different in this community, as a technology and school bond referendum did NOT pass a spring 1994 bond override. Participating schools do not have extra phone lines or jacks to spare, and Flagstaff teachers are struggling to convince their building administration that a computer and modem are of highest priority for their continued participation in the project. Most Flagstaff teachers must make their online connections from home. All principals and teachers from schools participating have an increased awareness of the need for a dedicated phone line and installation plans are underway in at least two of the four participating schools. The most impressive gain has been in the school with five participants—a team has continued to approach their principal with possible solutions. One participant is also on a newly-formed site-based management team, and technology (including telecommunications) is now included as an agenda item.

Preservice/Inservice Collaborations

Semester two of the Eisenhower project promises exciting collaboration. Participating teachers met during one of their Saturday afternoon sessions to plan preservice student projects. NAU students will use electronic mail to first meet their teacher partners. Partner teachers have asked that NAU students use their science and technology classes to plan an online project to connect the three school districts (eight different school buildings) in a science research project. A Saturday seminar will bring all participants together for a planning session on the NAU campus. Students will write a call for participation, solicit feedback from their teacher partners for suggestions and revision, and will then post the call for participation. Participating teachers will register for the project, and will work with their K-8 students to collect data following the project guidelines. NAU students will collect and organize data from all classrooms, and will make field trips to each school district to collaborate with their teaching partners as the project data is analyzed by children. NAU students and participating teachers will write reflective papers (online) on the process and evaluation of the collaborative project.

It is too early to predict the success of the preservice and inservice collaboration; network access may fall prey to the same problems found in the Texas/NAU penpal project reported above. Students have instant access to electronic mail via the Internet and campus mainframe computers. They are able to check their mail daily in a number of campus labs, in some dorms, and in the CEE Technology Teaching Lab. Teachers are still struggling after one semester for dial-up access. Even with phone line access in a school, the state network has not realized the need for adequate funding to provide enough modem pools for long distance 800 number access, and phone lines are usually busy during the school day.

Project Three: Student Teaching & Telecommunications Project

A pilot telecommunications project with student teachers using Macintosh PowerBooks w/internal modems and Arizona K-12 network software is supplying research data on the use of telecommunications for communication and reflective journaling with university supervisors and student teachers. Many schools are now connected to the Arizona K-12 Network, but there has been little instruction available for teachers, nor the opportunity to explore infrastructure problems found in remote areas such as on reservations (some reservation schools still use a phone switchboard system). The first phase of this telecommunications project involves case studies conducted by the CEE's Director of Student Services & Student Teaching and an educational technology faculty member. A small group of students are loaned PowerBooks (obtained through a university technology grant) which they use for reflective journaling during their student teaching semester. They are requested to send lesson plans to their university supervisor 48 hours in advance to an observation visit by their NAU supervisor, with an electronic discussion for feedback and development following the visit. During Fall 1994, studies are located in the Phoenix area, at a school on the Navajo Reservation, with an at-risk student, and with a dual-major student (both elementary and special education). A first-year teacher at a rural school site with a large proportion of Hispanic and migrant students is also included in the study.

Use of the Arizona network and the problems associated with high demand and inadequate modem pools has been interesting but frustrating to watch. Two student teachers use the network somewhat regularly, usually once each week, but they are located in the city of Phoenix where access has not appeared to be a problem. Their supervisors, however, are unable to access the network except through a dial-in 800 phone number which is almost always busy. Both students have exchanged messages with each other rather than with their supervisor. One supervisor has expressed frustration of busy signals and has sent very few messages. Another has used the network minimally. A student teacher in Kayenta, on the Navajo Reservation, must disconnect the school librarian's phone to access the network, only to find busy signals. She does not have access to a phone at home, and her participation has been almost zero. A student teacher in Flagstaff has been successful in connecting to the network, but has written that she sends her messages between midnight and 6:00 a.m. Her supervisor, while admitting she is not frustrated and sees herself as a pioneer, has never once been able to connect. This supervisor has kept pages of a log with entries that look identical: "Date...Time...Busy."

A first year teacher participant has probably been the most prolific writer and has managed to connect to her university mentor throughout the semester, despite problems in dial-ups and network issues with userIDs and passwords. The topics of messages and the detail and reflection are significantly different from the student teachers and the first year teacher. Student teachers have talked about how exciting student teaching is, how scared they are or how confident they are growing, how they can't believe the semester is almost over, and how they will miss the children. They have typically mentioned their supervisor's next visit, and how they are looking forward to the supervisor watching them teach. Both student teachers who have written weekly have commented on the support of their cooperating teacher and how much they have learned. There is little reflection noted on the teaching process. The first year teacher's comments seem to be of a different nature. The reflection appears deeper and messages have revolved around the need for resources, specific questions on how to bond with other teachers in the school, isolation, a newcomer versus super teachers, and is this really what I want to do? The tone is more desperate than that "heard" by student teachers. Wanting to do more than is possible is an overarching theme. But the partnership has been positive between the university mentor and the first year teacher. When the teacher reflected on inadequacy, super teachers, and trying to live up to personal expectations, a reply on how a new preparation, a new grade level or a new school will always bring back those same feelings of inadequacy and questioning of ability no matter how much experience a teacher has seemed to make a difference in the teacher's feelings of self. This is reflected in her message a month later, when the first year teacher commented on her choice to draw back and to enjoy the students and their activities in class. It is also reflected in her statement that she accepts that she can't "do it all."

The opportunities for student teachers and first year teachers to connect to their university community and peers will only continue to increase if the state network access improves. Continuation of case studies for several semesters will hopefully provide additional data on the feasibility of connecting student teachers to distant supervisors. It seems apparent in preliminary analyses that supervision will probably stay unchanged (e.g., number of visits to a school site), but perhaps more in-depth analysis after several semesters will provide information on how effective telecommunications is in supporting student teaching reflection and any effects communication access to supervisors has on the student teaching experience.

Summary and Reflection

This paper provides descriptions of several telecommunication projects in place at NAU. Each project reported is in preliminary stages and changes semester-by-semester. The changing nature of each project creates an atmosphere that is unsettling and often daunting for university faculty. Teaching and research sometimes are buried in the myriad of networking and access problems. A state network with dial-up access problems has almost stalemated inservice participation and a research project. Perhaps continued evaluation and sharing of such activities will provide teacher educators, administration, and state departments with sorely needed data on the opportunities and obstacles present in preservice/inservice use of telecommunications.

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Using Telecommunications to Connect Preservice Teachers and Classrooms

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This paper will describe two projects that connect undergraduate preservice teachers with K-9 teachers and their classrooms. Besides describing the processes used, the paper will discuss the successes, the roadblocks, the dead ends, and the disappointments. However, the focus will be on the successes! Finally, the paper will describe related projects that are connecting K-9 teachers and their classes with other K-9 teachers and classes.

Two Connecting Projects

One of the two major efforts that is being made in connecting preservice teachers and experienced teachers is an integral part of the program for elementary education majors. It takes place during the student's junior year, and is a part of the second of three clinical experiences that all students complete. The second effort is part of a multi-year project that receives funding through competitive grants to higher education as a part of the federal Eisenhower teacher education program.

Undergraduate Methods and Field Study

The first project involves undergraduate junior level students that are enrolled in three methods classes and a field study experience. The semester is divided into three parts. The first part is seven weeks long, and during this time the students meet the methods classes daily on campus for double periods. The second part is six weeks in length, and during the second part the students spend five hours a day in a school setting. For the third part, the undergraduate students are back on campus meeting the methods classes for double periods. One of the goals of using telecommunications was to allow the students to know the teacher, and the students they would be working with during the field study period while they were getting ready for the experience. A second goal was to keep in contact with the University Supervisor that would be visiting and evaluating their classroom during the Field Study. The telecommunication connection for preservice teachers was made possible since all students had Internet access through the university. For the regular classroom teachers the telecommunication connection was via a low cost "freenet-like" subscription.

From the very beginning it was decided by all parties that a major goal of the project had to be the improvement of the curriculum for both the undergraduate, preservice teachers, and for the K-9 students. No one wished this to be using technology just for the sake of using technology. Therefore, the methods classes adopted a constructivist learning approach and included a significant study of examples of curriculum integration across usual discipline areas. Many types and uses of technology as a tool were modeled. During the Fall term, 12 integrated activities were a part of the undergraduate mathematics or language arts methods classes. The two that were used most often by students in the field study experience were measuring and writing about pumpkins, and data analysis using stem and leaf plots, box and whisker graphs, and determining percents from circle graphs with beads. For the first year, it was decided to work with only one school building to receive students from the integrated methods classes. This school was located 30 miles from the campus.

During the first term, 39 students were involved with the experimental section of the methods classes that were using telecommunications. Twelve of the 39 students were to be assigned to work with teachers from the selected school, although all preservice teachers would be involved with telecommunications to teachers and students in the selected school.

A major problem was the logistics of selecting teachers and undergraduate students, car pooling, making original contacts between methods instructors and the classroom teachers, and initial uses of e-mail and the Internet. A few minor problems were encountered as the freenet was being set up regarding availability and access lines - unfortunately this was not totally resolved until almost the end of the term.

A major success was the idea and knowledge sharing that the undergraduate students were able to experience with their assigned teachers, regarding both curricular ideas to use technology, and the Internet as a resource. A secondary success was the continuing communication between preservice teachers and classroom teachers. During the Field Study portion of the semester, the school district established a district network to provide telecommunication between all staff members. The Internet background of the undergraduates provided a great foundation as the undergraduates helped the experienced teachers become active users of this new resource. Unfortunately, this network did not provide a gateway to the Internet.

Eisenhower Project Integrating Mathematics, Science and Technology

The second project was an Eisenhower program designed to help teams of mathematics and science teachers prepare integrated mathematics, science and technology projects for middle school students. One facet of this program was to assign a preservice teacher to work with each team of experienced teachers. Both the undergraduate preservice teachers and the middle school teachers were provided accounts on the Wisconsin Education Communications Board's PBS Learning Link. Wisconsin PBS Learning Link is a free service providing telecommunications to educators at no cost. It provides an 800 number for access, and has a gateway to Internet for e-mail communications.

A major technical problem was due to the fact that the ten teams came from all over the state, and used a variety of different hardware and software. Since very few of either group had any experience with telecommunication, it was necessary to conduct many small group sessions. The Eisenhower program included an intensive two week residential component. It was during this residential component that most of the small group instruction was conducted. Since all the problems that would arise were not considered in this initial instruction, follow-up was conducted by telephone, and in a few cases visits to the participant's schools.

A major success was the high quality of communication and sharing that has taken place between some teams and the preservice teachers. One undergraduate student has visited her team's school twice a week since the semester began. All the visits are coordinated via telecommunications. She has also conducted an intensive journaling project with one of the students in the classes that she works with during the weekly visits. The student is a special needs 5th grader that lacked previous experience with computers. The teachers have received help from the undergraduate as they plan new classroom activities, and the undergraduate has used her experiences in the school to provide background for the classes she is taking on campus.

Another student has had occasional contact with the summer team, but due to distance has not visited the school. However, his father is also a teacher, so the student introduced the Learning Link network, and its capabilities to his father, and now regularly uses it to keep in touch with one another.

Three Related Projects

Three related projects that have used telecommunications that the author has been, or is currently, involved with are the PBS Mathline project for middle school mathematics teachers, a K-12 Ameritech project, and a statewide curriculum frameworks writing project. The PBS Mathline project is a professional development project that uses video tapes with online discussions, all coordinated by a trained facilitator. The Ameritech project helps teachers to create and teach thematic units using the Internet as a major resource. Teachers are provided with equipment and a phone line into the classroom. The statewide curriculum writing project is preparing frameworks for integrating science and mathematics, as well as connecting language arts and social studies.

PBS Mathline

PBS Mathline is a professional development project sponsored in part by the public broadcasting network. The participants are mathematics teachers in grades five through nine. Nationally, there are 20 sites that are piloting this professional development model. Wisconsin has 60 participants in the project, the participants are divided into two groups of 30 and each group is led by an outstanding middle school mathematics teacher that has received special telecommunications instruction. A set of videos have been developed and are downloaded to participant's schools. After viewing the videos, the participants discuss online with their facilitator regarding the content and pedagogy of the video, and its abilities to further the implementation of the National Council of Teachers of Mathematics (NCTM) Standards for Curriculum and Evaluation. At present, Mathline is using a PBS special bulletin board that is not connected to outsider resources.

Ameritech Project

The Ameritech project provides laptop computers to classroom teachers where the local school has agreed to provide a telephone line to the teacher's classroom. During the initial year, the participant teachers learn to use telecommunications, the Internet, and some background ideas regarding developing thematic units. Some unit development is done online, and classes doing similar units connect and share student experiences and data as the units are implemented. The Ameritech project uses the university's connection to the Internet as the major telecommunications link.

Statewide Curriculum Guidelines

The Frameworks for Integrating Science and Mathematics (FISM) project and the social studies language arts project - Connecting The Curriculum (CTC) are federally funded projects that are providing related guidelines for all curricular changes in all K-12 and teacher education programs in Wisconsin. The writing teams have had a series of face to face meetings, but much of the work is done and shared using telecommunications. A Department of Public Instruction bulletin board provides the service for communications between development team members.

The author is a methods instructor in the first project mentioned, and is the project director of the Eisenhower project. He is the university liaison for the PBS Mathline project in Wisconsin, and is a consultant to the Ameritech project, and a member of the curriculum development team.

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LearningNet and *EastNet*: Creating a University/Business/Schools Partnership

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Governor James B. Hunt, Jr. created a vision for North Carolina to develop and implement a full service, statewide information highway using a fiber optic backbone. In order to accomplish this vision, large investments of capital were being made by the three major in-state telephone suppliers and various agencies of state government. Although genuinely intrigued by the potential for school restructuring that this technology presented, most school district administrators had many questions. Among their questions were ones such as: Who would determine the initial access site locations? What were the on-site equipment requirements and their costs? How much would the monthly operational costs be? Would the state absorb some or all of the startup and operational costs? What educational services would be provided to teachers and administrators? Clearly, without answers to these and many other questions, no firm educational customer base could be established. A statewide committee of practitioners and technical experts was formed to develop answers to these and other questions. With this technology developed and supported by the three major telephone suppliers in cooperation with state government, means simply had to be found to bring school districts, community colleges and universities online in an expeditious and cost effective manner.

LearningNet: One Solution

Recognizing that this technology had the potential ability to provide solutions to many of the problems that confronted eastern North Carolina, East Carolina University and Sprint/Carolina Telephone formed a unique partnership to seek innovative ways for using the North Carolina information highway technology to improve educational opportunities for rural children and their families. Through the partnership, named *LearningNet*, East Carolina University and Sprint/Carolina Telephone are initially working with two elementary schools in eastern North Carolina to create a pilot program that will generate new products, techniques, and procedures to meet educational needs specific to rural areas. *LearningNet* is the first North Carolina educational effort to draw upon the full spectrum of information highway technology to address children's educational needs. The purpose of *LearningNet* is to use innovative development, trial and application of the North Carolina information highway technologies to develop effective ways of teaching and learning, to overcome social and cultural isolation and to dream and to make dreams come true.

Sprint/Carolina Telephone. Sprint/Carolina Telephone has provided funding in the amount of $60,000 over a two year period in order to purchase equipment and services needed to successfully implement the project. In addition to monetary support, Sprint/Carolina Telephone has provided technical expertise, moral support and publicity for the project.

East Carolina University. East Carolina University is one of the 16 constituent campuses of the University of North Carolina system. The university is home to the largest teacher training institution in North Carolina and the national award winning Model Clinical Teacher Education program. In addition to the involvement of the School of Education, the School of Human and Environmental Sciences has been an active partner in the area of birth to Pre-K education.

School Partners. The initial participating schools are Riverview Elementary School in Hertford County and Roberson Elementary School in Edgecombe County. Riverview is a MS-DOS networked K-5 school of 750 students with over 75% of the students receiving free/reduced price lunch. Located in a small town, the school has a student population comprised of more than 80% ethnic minority children. Roberson Elementary School, a very small rural school, is a Macintosh networked school of only 200 students with over 80% of the students eligible for free/reduced price lunch. Seventy-five percent of the children at Roberson are ethnic minority students. By using two very different sized schools with different computer hardware applications, the project will be able to be replicated in any networked school environment regardless of school size or computer configuration.

SmartStart. In addition to the school partners, the Hertford County Partnership for Children, is also a member of *LearningNet*. The partnership, formed under the SmartStart initiative of the State of North Carolina is charged with the responsibility to ensure that every child in Hertford County enters school healthy and ready to learn. SmartStart provides needy individuals with access to quality, affordable child care and health care and other critical services.

ENCCARE. The project is administratively directed from East Carolina University's School of Education through its newly formed educational consortium, the Eastern North Carolina Consortium for Assistance and Research in Education (ENCCARE). Created in August 1993 ENCCARE is partially funded by the North Carolina General Assembly and is one of eight regional consortia charged with delivering school restructuring and economic development services to specific areas of the state. The consortium is composed of 27 school districts, 14 community colleges, five institutions of higher education, and numerous business partners, such as Dupont and Proctor and Gamble. Among ENCCARE's goals are assisting school districts with restructuring in the areas of home-to-school transitions, school-to-work transitions, leadership development and technology.

EastNet

As the schools were networked internally and the formative stages of the information highway (in the form of the Internet) were in place, a cost effective means of accessing the Internet was sought. In order to provide a point of connection for the Internet and to use the existing technologies while awaiting the full service information highway, ENCCARE used some of its available resources to create an Internet gateway. In addition to the *LearningNet* partners, all schools who are members of the ENCCARE consortium in northeastern North Carolina can connect to the Internet using this gateway.

The gateway, named *EastNet,* incorporates an Internet address with a bank of "1-800" toll-free and local telephone lines. Teachers and administrators can connect directly to Internet through *EastNet* and are provided such services as e-mail, FTP, Gopher, Telnet and World Wide Web browsing. The *minimum* hardware/software requirements for connectivity are a PC with a 386DX processor, 4 Mb RAM, 5 Mb of available hard disk drive, a 14400 baud Hayes compatible modem, MS-Windows 3.1 or better and a standard telephone line. The recommended hardware/software configuration is a PC with a 486DX processor, 8 Mb of RAM, and 5 Mb of available hard disk drive, with the other minimum requirements being the same. Macintosh services and minimum requirements are currently being developed.

User parameters have been established regarding such areas as limiting free monthly time on the "1-800" toll free numbers to 40 hours per account, 90 day active/inactive account usage, deletion of unchecked mail and listservs, and methods to handle inappropriate activity. Although students are not initially being permitted direct access, eventually, supervised students may be permitted to use teacher accounts to access the "Net."

LearningNet partners and other school group users are connected directly via dial-up to *EastNet*, which will use university faculty and graduate students to work closely with local school site administrators, teachers and parents to develop new products and procedures. For example, an "Experts-on-Line" service manned by graduate students and professors has being created in the four major curriculum areas of Communication Skills, Mathematics, Science and Social Studies to offer direct assistance to teachers.

Mine Fields to Avoid

Training, Equipment and Time. Local building-based leadership were asked to assess the competency level of the faculty and staff in order to develop appropriate training. Their assessments were accepted as to the degree of expertise that the average teacher and administrator had regarding computers. Initial training was to be provided at the assumed level of expertise. It was quickly discovered that the initial training was aimed too high and had to be scaled back to a lower, more basic level. This training, provided by East Carolina University faculty, and funded through ENCCARE was provided over four weekends of Friday nights and Saturdays. This weekend training schedule proved to be a general inconvenience to the participants, but did require considerable commitment on the part of the participants.

The old adage, "Things always cost more than they cost" has proven very true in this project. The equipment needs for the initial startup for the gateway connection far exceeded our projections. As new hardware came on the market our plans changed, resulting in our ordering better, but more costly equipment. In the area of software, the new Windows 3.5 NT was installed recently and will provide better use of the system, but this change delayed startup. All of these changes will assist us in the future but resulted in cost overruns initially. The long distance toll charges were initially very high but with the cooperation of Sprint/ Carolina Telephone a more favorable rate was negotiated.

The administrative and technical time required to design and implement the project were the mostly costly items. Incalculable hours have been spent developing the entire project. In the *LearningNet* phase of the project, the Planning Team has held many meetings discussing areas of mutual concern and building trust and understanding for the different roles that each group brings to the planning process. The Systems Operator has also incurred large demands for his time in developing the entire system.

Future Plans

A group of teachers and media specialists are reviewing all available Internet services and correlating these to the North Carolina Standard Course of Study. By doing so, future users will benefit by knowing directly where to access certain files and information. All teachers are being trained to Level 4 computer competency as identified by the North Carolina Department of Public Instruction.

Other specific areas of expertise and interest are being developed for the "Experts-on-Line" phase of *EastNet*. Sprint/Carolina Telephone employees continue to volunteer technical assistance to *LearningNet* and all partners are seeking additional resources for such planned programs as a "Take Home Laptop Computer Program" for students and parents. A CU-SeeMe component is being developed for each site, pending funds to implement the two-way, audio/ visual classroom component for each site.

Officials from both school districts identified parent and community involvement in schools and overcoming their schools' social and cultural isolation as crucial to their future success with the children they serve. As a result, the schools are being connected to a parent information help line as a further means of improving home-school communications. The two-way audio/visual classrooms will enable parents to access services from the university that they would find ordinarily difficult to do.

Both Walt Disney and Martin Luther King, Jr. had dreams that came true. Our dreams for the children of eastern North Carolina are coming true as a result of *LearningNet* and *EastNet*.

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WCUMicroNet: Putting Purpose into the Network

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WCUMicroNet is a telecommunications network that has been an outreach program of Western Carolina University since 1982. Begun as a way for the Biology and Chemistry/Physics Departments to aid local high school teachers in the preparation of college-bound science students, WCUMicroNet has evolved into a statewide, K-12, multidisciplinary computer network and Internet listserv site, including help desk, printed support, and workshops for inservice and preservice teachers, administrative personnel, WCU faculty and students.

The project began on the university's mainframe computer. This was followed by acquisition of a Tandy 6000 with the help of a 1985 grant from National Science Foundation. We received an equipment grant from Apple Computer to put computers into 14 participating schools and replaced the server with a donated Zenith 386/33 in 1990. There have been other minor sources of funding and equipment, but since 1987 we have received full operational support from WCU, including a SUN SPARCstation 5 in 1994 for use as our server.

Subscribing schools access WCU MicroNet through our 800 lines, local phone access, or by Telnetting to micronet.wcu.edu. Some areas' schools access a local telephone number to Telnet directly to WCU MicroNet.

Individual user accounts have been designed with multiple usage in mind, in that a school might have a single account on MicroNet, but individual teachers can participate in a variety of activities without confusion by supplying their personal name when reading conference messages, archived lists, participating in projects, etc. The only area which is necessarily communal for the account is e-mail, and within the PINE mailer they can distribute their own saved mail to individual folders.

User Support

The most important support for users is a clear, straight forward, understandable menu system to guide users from level to level and point to point. To view the menu structure of WCU MicroNet, Telnet to micronet.wcu.edu and login as demo. Use demo1 as the password. This account will not allow access to the entire system and functions, but you can get a feel for what we offer.

In print, we supply our subscribers with a *User's Manual*, *Quick Reference Card*, quarterly *Gazettes*, and other project brochures and intermittent publications and instructions. The *Gazette* incorporates news about new features, usage techniques, and curriculum ideas for WCU MicroNet and some Internet functions.

We also provide an 800 help desk staffed during regular office hours, presentations to potential users, hands-on workshops, and other user support as needed.

Features

Beyond the universal feature of e-mail, WCUMicroNet offers conferences, projects, contests, databases, tutoring, a chat area, and complete access to the Internet, including archived educational Internet lists. Using WCUMicroNet in North Carolina, students can learn all of the telecommunications skills necessary to pass the computer competency test for eighth grade scheduled to begin in 1996 without using the Internet, though their research is enhanced through this expanded access.

E-mail. We have two electronic mailers available for use: mailx from the SUN Solaris Operating System and PINE. Choice of mailer depends on the intended usage and their telecommunications software. Our Quick Reference Card provides an immediate level of support for both sets of commands.

Conferences. The conference area on MicroNet (on other systems referred to as a bulletin board or forum) provides opportunities for collective interaction. The topics vary as a reflection of current subscribers' interests and are mostly temporary in nature. Some conferences continue from one year to the next, including: *Announcements*, which informs about new things online and new techniques and ideas from a variety of sources, *InternetHelp*, moderated by a volunteer who is also a part time specialist for Microelectronics Center of NC serving the western region of the state, *Astro.Space*, moderated by Tom Hocking from Morehead Planetarium, a connection for viewing the world in its broader context, *MicroNet 95*, includes texts from WCU MicroNet Gazettes, HELP*!!*, and *MicroPals* .

Science is a new conference area for science related topics of all levels and disciplines moderated by a WCU faculty member. Some of the conferences are not available to general use. These include conferences for student teachers and WCU course discussion areas. Other conferences are established for county school system use.

More like a newsgroup than an Internet list, the discussion on a MicroNet conference takes place in the CONFER menu area rather than being handled through e-mail, thus reducing possible confusion in a single school account used by multiple teachers.

Projects

Our projects are designed for K-12 student participation and include discussion/keypal opportunities, contests, and opportunities to share.

BookRead. The BookRead Project has been in place for five years and involves partner classrooms of students in discussions of literature, such as books by Jean Craighead George or on topics such as the holocaust. In the course of a BookRead Project, schools may have exchanged videos of their class, pine cones and seashells, dozens of notes and letters, and involved civic groups, parent volunteers, resources available through WCUMicroNet, and even the authors of their focus.

To find classes interested in becoming partner BookReaders, we have established a MatchMaker conference, which is also currently available as an Internet list as BR_Match. To subscribe, send the message: sub br_match to mailserv@micronet.wcu.edu. Since WCUMicroNet is a service requiring a nominal subscription, however, the full services of the system are not available to non-subscribers beyond making the connection with a class with which to exchange e-mail.

For subscribers to WCUMicroNet, the project includes a special conference area for their messages (allowing more than two classes to participate in a single discussion,) a teacher support conference area, assistance in the round-table chat format (making sure the classes actually get connected at the appropriate time,) and support in finding authors. Of course, the faculty at Western Carolina University may also be considered resources available to the teachers in their planning and implementation of BookRead projects, but all projects are designed and books chosen by the teachers for their individual classrooms.

A book about the BookRead Project on WCUMicroNet, *Computer Conversations*, by Jody and Saccardi, (published by National Council for Teachers of English), is due for release in 1995. It contains a description of the project and reader-response techniques and a variety of firsthand experiences by participants.

Careers. The new Careers Project brings together, electronically, professionals by category to discuss how they came to be what and where they are, be they doctors, writers, government employees, retail businessmen, etc. For two weeks, members of a given professional group discuss their situations among themselves, followed by two weeks when students may submit questions or comments. Some professionals remain active to respond to students throughout the year, but all of the conversations are archived to allow student access to the information on a longer term basis. Some individuals use the chat feature for a more immediate conversation. This project, coordinated by a community volunteer, is available to all grade levels.

Science Faire. The Science Faire is a competition based on science fiction stories about a galaxy of intriguing characters, each episode of which is accompanied by five multi discipline science, math, geography, economics, or linguistics questions. K-8 classes or high school teams compete to upload the correct answers before others, although they receive credit for attempts as well. WCUMicroNet provides a semester's teachers' guide online and in print, with tips for class preparation. There is also a teacher's forum for discussion and help, as well as access to the project director, a WCU alumnus.

LitMag. LitMag is a repository of student writing from all grade levels through the years. It is where the poetry is stored from previous Poetry Contests, which being each year in November and conclude in March. Entries received through the network are selected by the Poet-in-Residence at Western Carolina University to continue to the North Carolina Writers' Network for final judging. Three top winners are selected for prizes in each of three age categories and haiku for K-5. Those being judged at the state level and their school libraries receive a copy of the poetry book which includes all of the selected poems. Submissions are limited to one per student, and must be received online.

Dr. Psyche Speaks. WCUMicroNet also includes Dr. Psyche Speaks, an area just for inservice and student teachers seeking help with interpersonal and group relationships that arise in the professional setting. This project is supported by the Psychology Department at Western Carolina University.

Databases. A variety of data resides on WCU MicroNet, including discipline segregated, searchable lesson and unit plans, resource references including software, group educational travel sites, even wit and wisdom. Files include individual files for each account holder, the location for storing FTP documents while in transition, etc.

Tutor/Testmaker. There is a special area designed for online, ten question, multiple choice quizzes. There are resident question banks in the sciences, math, and history for high school level students, and the opportunity for teachers to select particular questions or add their own in designing special help for particular students/groups at any level or discipline. The students have a second chance to answer correctly, and the scores are posted at the end of the test and saved in the teacher's file online. There is also an option for teachers to download a quiz and answer key for use offline.

Chat. The chat area is a multi-user platform realtime conference area where students, teachers, authors, faculty, and others can speak with each other in an informal, line by line conversation which is more immediate than e-mail and more recordable than a phone call. You can ring others currently online to join a conversation.

Internet Access

WCU MicroNet is not only accessible through the Internet, we provide access to a variety of functions within our menu framework.

Lists. We subscribe to many education-oriented lists, which we archive for the convenience of our subscribers. They can opt to Read all new messages since they stopped at a previous session, or Browse the entire list of headers to find those messages they wish to review. The selection of lists is determined by user request or educational validity.

The currently archived lists include: aahesgit, aera-k, bookbrag, cig-l, cosndisc, eceol-l, ednet, edstyle, edupage, flac-l, flteach, friends, hilites-list, ideas-list, iecc, iecc-discussio, iecc-projects, infobits, k12-euro-teach, k12admin, kidsphere, kidlit-l, kidzmail, lm_net, memories, middle-l, mini-jir, natlit-l, nesput, novae, pen-pals, presto, safari-l, scifaq-l, teslk-12, yescamp, and weas.

Telnet. The Telnet menu includes several sites including Gophers, help files to aid access, and an "other" option to allow users to Telnet to the site of their choice beyond our menu listings. We plan to be a Gopher server in 1995. Current Telnet sites available as menu listings on WCU MicroNet include: Archie software source lookup, Ask ERIC libraries (includes Discovery & TLC lesson plans), Montana's Big Sky Telegraph, Cleveland Freenet, Minority Scholarship Information, Friends & Partners (Russian & American) Information Service, Jason Online, K-12 Technology by Design, Library of Congress Information System, MIT's MicroMUSE, NASA's Spacelink, Argonne National Laboratory's Newton, Nysernet's Gopher service (w/ CNN News Feeds), The Society for Informational Technology & Teacher Education, Simple WAIS, Connect with University of North Carolina computers, University of Michigan Weather Underground, and Global Learning's WorldClassroom.

FTP. Our ftp menu includes several educational, government, and software sites, as well as an "other" option. Sites available as menu options include: the AskERIC electronic library, the Garbo server (Finland), Kermit Source / Columbia University, NASA's ftp site, McAfee's ftp site (virus protection software creators), Meteosat Pictures from Free University of Berlin, MicroSoft Corporation's FTP site (has msdos 6.2 upgrade & ptr drivers), Smithsonian Institution's Photo1 Archives, Macintosh software, and the U.S. Bureau of the Census.

Finger, Talk. XTalk and YTalk and finger are also available options.

On Campus at Western Carolina University.

Student Teacher Support

WCUMicroNet supports telecommunications needs of student teachers in the field by linking them with their current peers, their university supervisors, and those students preparing to "walk in their shoes" in the future.

Other Applications

Many other classes available on campus also incorporate the use of the network for regular class assignments and communication. Others might replace part of the class meeting schedule with online meetings using CONFER or CHAT. Assignments are submitted and student/faculty communication is enhanced through e-mail. Classes make use of the tutor function for online quizzes, as well as lesson and unit plans and resource references in the databases as examples and guides.

Conclusions

The WCU MicroNet model for teacher support, student enrichment, and continuing education opportunities has delivered much and has continued promise. Through subscription figures, usage records, workshop and presentation responses, and unsolicited feedback, we have modified the system design, altered content, expanded services, and developed purpose for the network. What have we learned in the course of twelve years of supporting teachers, students, faculty, and resource personnel?

1. Telecommunications technology must be kept simple to use, with initial instruction and continued, accessible support.
2. There must be a compelling reason to draw the individual user to master the technology.
3. There must be a correlation between the defined curriculum required by the state and the classroom project design involving telecommunications.
4. There must be support for the use of computer telecommunications from the highest levels of the school, district, and state, which includes recognition and compensation for development of innovative classroom use of technology.
5. There must develop a supportive community of success among peers.

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Interactive Technologies in Teacher Recruitment: Linking School to College

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As witnessed in the last two decades, there has been a steady decline in college and university recruits into the teaching field. Recruiting highly skilled and potentially strong candidates into teaching is essential when considering the concern expressed by national leaders regarding the type of skills needed by high school graduates for the twenty first century (Shanker & Geiger, 1993).

In order to develop highly skilled and talented students who are able to use technologies efficiently, the need to recruit for more qualified, highly skilled and technology-wise teachers cannot be underscored (Shanker & Geiger, 1993). Educators today must have these specific abilities to foster the types of learning our students need in order to be competitive in the global market and its economy (Ausland, 1990; O'Neil, 1991).

Recently, the profession has witnessed a growing concern that traditional strategies for recruiting teacher candidates have not worked. Part of the problem lies in the lack of curricular innovations within higher education institutions and the relaxation of program standards in teacher training programs. New teacher recruits cannot be fully prepared in the current training curriculum lest professionals believe that the current preparation programs are well equipped to handle development of skills for modern technologies (Carrier, 1992).

Colleges and Universities engaged in teacher training must develop their own new technologies in professional recruitment. In a decade of declining interests in education and diminishing financial resources, integrated systems with high cost-efficiency ratios are in great demand. While many believe technology to be electronic hardware and software, educators need not accept this to be the only definition.

Technology can be perceived as an innovative method or strategy in the processing of different types of information. In teacher recruitment, technology should be viewed as innovative methods and strategies that professionals use to solve problems in the field.

State-of-the-Art Technology in Micronesia

Professionals have seen the numerous opportunities that technological advancements bring to a university campus. With the various different campus technologies in place such as the Video Information System at Ball State University; the Dartmouth College Cyberspace Research on multimedia; the Massachusetts Institute of Technology Speech Recognition Program at the MIT Laboratory; and the University of Arizona's Community Systems Laboratory, research opportunities have flourished. Every college and university in America should strive to develop its own unique response to the world of modern technologies (Syllabus, 1992).

The University of Guam (UOG), while not as advanced as the previously mentioned institutions on information technology, has become Micronesia's center for electronic and related advancement in computerized technology and information resources. In attempting to keep in-step with the rest of the United States and the world, UOG has paced itself to provide for the hardware and software needs of professionals and students in the region.

The time has come with the new installation of the University's computer systems (IBM 4300 series DEC 5500, DEC VAX 4000 with virtual storage feature) and local area networks (LANs) in and around the campus. UOG's Robert F. Kennedy Memorial Library is a shining example of advancing technologies. It is fully automated with the application of the Dynix system used for cataloging, circulation, reserves, serials, and other major functions that are related to the overall operations of the library. The Library holds numerous subscriptions to many major CD-ROM reference products including access to OCLC (cataloguing, referencing, and interlibrary loan functions) and Dilog as well as Internet and other searching and downloading programs through electronic means (UOG Catalog, 1994-95).

The University of Guam is poised to be the multimedia center of Micronesia. In recent times multimedia has become a popular concept in the field of education particularly in helping teachers and students get familiar with advancing technologies of the world (Greaves, 1991). Regional experimentation with multimedia is ongoing in an effort to deliver a multiplicity of needed services to the peoples of Micronesia. These include communication links for weather information and dissemination; educators' presentation tools; conducting research studies; implementing distance education; video, radio and computer conferencing; oceanographic experiments; and economic and political status discussions. Multimedia undoubtedly will play a vital role in helping to develop and shape the emerging nations and countries of this region in the Pacific basin.

Long Range Vision for Education

Several years ago, administrators and faculty in the College of Education at UOG embarked on an ambitious project to develop the first computer-linked network system on campus and in the region. Through a Federal grant project for institutional strengthening, COE developed a master plan at which COE was to be the first unit to implement the most comprehensive LAN system on campus to service the needs of its increasing student population and the demand for academic resources by its faculty.

The success and completion of this link has been noted (San Nicolas, Shuster, Caplan, & Foster, 1992) and continues to provide for staff and faculty to this day. The completion of the construction of the new COE building in the past year has brought more attention to the need for careful assessment of the impact of such technologies on the operations and services of COE. The College has progressed to what many professionals view as in-step with the right technology at the right time.

The Professional Teacher Recruiter's Office

One of the more innovative actions that the College took, even prior to the implementation of its network system, was to develop the professional teacher recruiter position. This position was handled by a faculty member whose experience in recruitment helped increase student majors and provided for their efficient advising as students matriculated into their programs.

The recruiter effectively used campus-wide facilities to promote education as a college major. The office worked closely with the Office of the Registrar, the various scholarships on campus, the President's office and all the deans of the various colleges. As part of the recruiter's responsibilities, speaking engagements for career days were arranged with all the six public high schools for the purpose of sparking interest in teaching careers in high school students.

One of the most profound impact this office had on campus was the organization of the Future Educators of Guam Association (FEGA). In 1991 FEGA became one of many student organizations officially recognized by the Student Government Association of the University of Guam. It became active in fund raising activities, membership drives, faculty-student get-togethers, commencement ceremonies, and the University's Charter Day. FEGA became an outlet for students who wanted more out of their university life other than just attending classes and studying in the library.

However, the recruiter position lasted only two years. The Guam Legislature abolished the position due to its low recruitment record and inefficient cost-benefit ratio. It was evident that the office needed much more support in the recruitment process than FEGA or carting around brochures to give to interested high school students. A better, more organized and innovative plan had to be developed so that there was a consistent flow of recruits into the College. The need to also provide pertinent information about programs to these students was recognized early and the delivery of the information helped students decide early about their majors. This information was used to plan for course registration, advising, certification, and employment.

Trouble in Paradise

With the new and emerging technologies in place at the University and the College, public attention then focused on the institution's inability to produce local teachers for its one and only public school system. With the decline in the number of recruits over the years, a perplexing problem arose within the public school system. Student enrollment jumped an average of five percent per year with the influx of Micronesian and Philippine immigrant students and their families.

School enrollment reached almost 33,000 in 1993. This was up from an average of 29,000 per year in the last five years. The increase in the school population was unanticipated let alone the problem of teacher shortage. With a professional turnover rate of 20% or about 400 teachers per year, it was inevitable that the local government had to act to counter the trend and bring some stability to the teacher shortage dilemma.

Many teachers and professional support staff were recruited every year from off-island and mostly from the mainland U.S. Despite the good job opportunities, many of these professionals left after two years. Some reneged on their two-year contracts due to various problems encountered in the school system or elsewhere on island.

A Promotional, Recruitment and Scholarship Program

In response to this teacher shortage, the local legislature mandated a scholarship program to include a recruitment and promotional program to offset the troubling trend. The Guam Teacher Corps Scholarship Program (GTC) which is Public Law 21-88, was designed to steer local interests in the direction of teaching and other educational careers. The underlying legislative intent was to foster a perception of commitment to education by the local government and to address the public's immediate concern about teacher shortages in the schools.

In the second year of its operation, the administration of GTC developed an ambitious promotional and recruitment master plan. This plan included the development of induction programs within the public and private high schools on island. The identification of a Teacher Corps Advisor (TCA) for each school was a major part of the plan in hopes that this strategy would bring about the numbers needed for enrollment at UOG and in the College. TCAs were to be identified by building Principals in consultation with the Director of GTC and the Associate Superintendent of Secondary Schools. The search process was to be competitive with a two year appointment and a stipend for compensation.

In addition to TCA's, GTC developed and implemented a promotional program in the elementary and middle schools whereby high school and college students in education participated in recognizing interests in teaching. The program brought together inservice and prospective teachers in partnership to promote and recognize interests in very young children who wanted to become educators in the near future.

Prospective teachers brought with them concrete symbols of achievement and success from their schools including diplomas, athletic letters, yearbooks, pictures, report cards, honor roll certificates, and numerous trophies and medals won for various academic and athletic competitions. They showed their memoirs to the students in hopes of sparking their interests to become teachers. Schools and students who participated were honored by GTC and the University in a Spring Convocation and Awards ceremony. This program was dubbed "SPIRIT" which translates to Schools and Students Participating In Recognizing Interests In Teaching.

Critical Role of TCAs

TCAs were to recruit advanced high school students to start taking courses at the University and supporting them through GTC scholarships. Advanced students must still pass UOG's English and Math entrance examinations and test into College Algebra (MA 161a) and Freshmen English (EN 110). They must also meet University regulations for health and other University program requirements. Once enrolled, these high school students were to major in one of the many education programs at the College or any teacher tract programs in other colleges within UOG.

As TCAs were identified, their roles became increasingly specific and critical to the scholarship's promotional and recruitment aspects. TCAs were required to keep computerized databases of their students for the purpose of tracking and monitoring progress and continued interests in careers in education. They were to maintain contracts with students; develop extra curricular activities to promote the profession; engage in discussions with other faculty about teaching careers; and form student associations to foster educational careers.

Link With The University

As TCAs became better organized and understood their duties and responsibilities, GTC became more involved in helping them develop their offices to function as envisioned in the promotional and recruitment master plan. Each TCA was to have a computer that would be able to hold demographic information of high school students recruited into their school education associations. These data were to be easily accessible to the GTC office in hopes of recruiting students as early as in their freshmen year. Student contracts for advanced seniors attending the University also were to be kept in the computer including a separate file cabinet for hard copies.

The TCA office also was to include storage for CD-ROMs developed for the school and in collaboration with the GTC Office and University. The CDs were to hold pertinent information about the University, the various College of Education programs, a full information section of all the faculty and their credentials, and various groups and activities that may be of interest to the students.

TCAs were to communicate with the GTC office through a modem connected to their computer and linked to University resources including the library, the research centers, and the College of Education. It was envisioned that a "star-type" network system was preferred as individual schools were to report directly to GTC and the University. However, modems and specific electronic mail software were to be purchased for the purpose of communicating with other schools in the linkage.

The Basic Network Plan

The network master plan envisioned for this model of teacher recruitment include the following phases:

1. Identify Advisors at the high school level
2. Organize Work Station Office in the Link
3. Purchase hardware and software to connect with the GTC Office at the University
4. Develop Video Tapes for Promotion and Recruitment
5. Develop CD-ROMs for Promotion and Recruitment
6. Prepare GTC Office for on and off-campus clearinghouse activities
7. Integrate computers with multimedia "add-ons" including digital full-motion video (e.g., Intel's Digital Video Active, DVI), scanners, printers, etc.

The proximity of the GTC Office to the College was essential in the plan. The Office is located within 100 yards of the new COE building. GTC's office space also has expanded from 200 to over 700 square feet.

In the GTC office and organized in sections are program advisory worksheets; brochures about the University and the scholarship; graduate degree program outlines; GRE (Graduate Record Exam) applications including an individualized computerized tutorial program; UOG and COE admission applications; Teacher Certification requirement worksheets for Guam; Certification Requirements for the 50 States; and the complete master file of all scholarship recipients. Also on file are the complete master list of the names of high school students (seniors only) and their respective addresses and phone numbers. A special file section has been designated the University files which include the master list of financial breakdown for every scholarship recipient and completed exit surveys of graduates.

One workstation is completely linked to the Internet and the University's CPU system. One of the most important features of the linkage is the complete integration of the University's Admissions and Registrar's COLLEAGUE© system whereby the GTC Office could review (scan only) student transcripts and registration processings.

Student Response

For students, the accessibility to University resources would be a morale booster. Imagine being online to review programs, course descriptions, faculty biographies and other useful information necessary to make a decision about college life and the type of opportunities available there. All these data would be available to student recruits without having to leave the school campus.

Students also could watch a short video presentation about the University and its resources through a program already developed for recruitment. The match-up between computers and videos have already been researched and purported to be the next integrated technological trend of this decade (Polilli, 1991). Computer conferencing with simultaneous video interaction is seen as the next step in this successful recruitment model. Some researchers at the University of Guam have already begun experimenting with computer and video conferencing to improve the quality of programming in distance education.

Summary

Technology in education is often perceived as hardware in the form of micro computers combined with a multitude of software that are used to enhance student learning and retention of teacher instruction (Jurshan & Dawson, 1992). While this view is widely accepted, it often confuses or misconstrues the notion that technology could also be perceived as "non-hardware or software" and innovative methods used by educators to enhance student learning in the schools. Many widely held beliefs in technology often overshadow this latter perspective and the word's meaning is lost in one area of conceptualization.

While computerized technology is often viewed as an educational tool to develop certain skills and abilities in students, it must also be infused in helping to recruit for the profession. The integration of computerized technology in the process of recruitment can only enhance its feasibility as a tool to promote an image of professionals who have the knowledge and abilities to work efficiently with modern technologies. More importantly, this tool should formulate an image of educators using information and disseminating them efficiently.

With teacher recruiters leading the way, it is possible that more students would venture to evaluate education as a career choice given that professionals in the field have developed innovative recruitment programs to attract the brightest and most talented candidates into the profession. If the rest of the profession follow suit and become more conscious and skilled in the use of integrated and multimedia technologies, then the overall quality of teacher training programs would improve significantly. A high-quality educational technology component in teacher preparation programs certainly would tremendously impact on public school education and student performance (Kelly, 1990).

Computerized networking using integrated multimedia systems may be a dream to others but it can become a reality. Computers that communicate with each other would encourage educators to collaborate thus forging professional relationships and the sharing of critical information. For educators worldwide, collaboration through computer networks has become a very real part of the technological dream (Noorda, 1990). Collaboration and networking certainly would enhance and make teacher recruitment more efficient in the future.

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Constructing Cultures in Distance Education

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When we were young, we learned to walk on the left side of the road, facing the traffic, and to ride bicycles on the right side. Our mothers taught us, "Speak respectfully to your elders," and "When you introduce people, introduce the man or boy to the woman or girl." When some of us were young, our mothers taught us to say, "Yes, ma'am" and "no, sir." (We grew up in the South).

There were, however, no computers in the childhood environments of most of us, and certainly no computer conferencing etiquette in our mothers' stores of knowledge. Neither did we know about listservs, or two-way interactive video conferencing classes, or computer conferences. There was no way for us to grow up with a common set of expectations about the social encounters we face in distance education experiences. No broad-based culture exists yet for distance education. Thus, we must be deliberate in engaging with students in order to create cultures that include formalized conventions for interaction.

This paper first focuses on a philosophical and theoretical base for developing social systems within various mediated-learning contexts. We then describe some misunderstandings that arise from the newness of the developing cultures. Finally we describe some of the social environments for constructing cultures in distance education.

Constructivism as a Useful Worldview

Constructivism is a worldview or paradigm that defines learning as the process of constructing meaning about, or making sense of, our experiences (Candy, 1991). A number of learning theories are related to this worldview. Those—such as Piagetian-based theories—that emphasize individual or individualized meaning-making are less relevant to the current discussion than are those that emphasize the social making of meaning.

For instance, the idea of the sociohistorical nature of learning was introduced by Russian researcher and theorist, Lev Vygotsky (Wertsch, 1991, substitutes the term sociocultural). Vygotsky acknowledged that individual experience is part of what shapes a person's understanding of any situation; but he emphasized that it is only one influence. Our interpretation of the world is derived largely from the social environment in which we experience the world. As one of Vygotsky's later interpreters said, "We literally live in the experiences of others."(Kozulin, 1990, p. 81).

Language is one key social creation within which we live. We learn our first language from the people around us. Throughout life, we expend large amounts of time and energy negotiating the meaning of words and of language structures—in other words, participating in the social construction of meaning as it is expressed in oral and written language (Kozulin, 1990).

We actually learn many ways of speaking, almost as multilingual children learn unconsciously to speak one language to father and another to mother. Vygotsky referred to speech genres as oral or written language patterns existing within the same language but being used only in specific contexts. The genres don't so much differ in word meanings as in specific utterances and specific patterns of speech (Kozulin, 1990). Conventions can be thought of as individual rules within the genre.

Poetry is a genre of literature, for instance, and so is prose. We perceive or judge poetry with different sets of rules than we use to perceive or judge prose.

Our patterns of greeting one another represent a whole set of conventions: one set of phrases, sentences, and discussion topics for new business acquaintances; another for longtime business acquaintances we see every day; yet another for longtime business acquaintances we see only at occasional meetings. If we can extend the idea of conventions beyond words to actions, we may be said to have one set of conventions of greetings for business (handshakes, for instance), another for social occasions (hugs or backslaps), a third for family (embraces or kisses). The convention that we choose for greeting an individual tells how close we perceive the relationship to be. Uncertainty about the proper convention indicates that we are uncertain about the relationship we want or about the relationship the other person wants or about whether both parties agree on what is wanted.

Perhaps we could phrase the current problem as one of underdeveloped genres for the various technologies of distance education and perhaps for different groups of individuals using the same technology. Older technologies—correspondence courses, video tape or audio tape distribution, radio, and television—have two advantages: they have had more time for cultures to develop; at the same time, these technologies are less interactive and thus require fewer conventions about how interaction will be accomplished. The newer, more interactive technologies include audio teleconferencing, both one-way and two-way video conferencing, and various forms of computer-mediated communication (e.g., e-mail, computer conferencing, and bulletin board systems [BBS]).

Examples of Cultural Problems in Distance Education

Two examples show how the lack of common culture can create problems in the more interactive forms of distance education. Anyone who has participated in a two-way video conference utilizing video compression has experienced the awkwardness created by the delay of video transmission. At each end, we find ourselves simultaneously pausing politely to let the other person speak and then simultaneously speaking in response to each other's pause. Groups who frequently meet via two-way video conference may establish signals to identify the current speaker or to determine who should speak next. These signals have not been established as conventions for this format. However, if we as teacher educators report to a wide audience both successful and unsuccessful video conferencing conventions, we will contribute significantly to the construction of a shared social environment.

The second example shows that different conventions do or will exist for different purposes, even within the same distance medium. One misunderstanding was barely averted when two seemingly similar uses of computer-mediated communication were shown to represent different cultures. Thrust into a computer conference to discuss the value of using technology in a science curriculum, an eager preservice teacher posted the first message to the conference with a flippant challenge to his professor: "She'll never read this message; she leaves that to her graduate assistant." This introduction to a computer conference might have had serious implications for the 20 other preservice teachers and the two teacher-mentors.

However, an understanding graduate assistant, who was experienced with the genres of both BBS and academic computer conferences, recognized the preservice teacher's style of writing as culturally acceptable for a BBS but not for an academic computer conference. The graduate assistant privately communicated to the professor her belief that the inappropriateness was a matter of not knowing culturally appropriate behavior rather than of trying to cause trouble. The professor deleted the inappropriate message and communicated individually with the student.

These actions provided the student, the other conference members, the other two moderators, and the professors with an atmosphere more appropriate for scholarly discussion. Without the constructivist perspective on the creation of culture, teachers may react negatively, believing that learners are not taking seriously the learning goals of the encounter. They may even be personally offended by the actions of some learners.

Environmental Influences on the Creation of Distance Education Cultures

Ultimately, cultures are created by the people who participate in them. However, many factors outside of the group influence the culture being formed by the group. In terms of distance education cultures, influences on development may come from publications, groups, individuals, and computer-mediated communication (CMC).

Publications

Publications offer varied perspectives on distance education, which in turn influence, to a certain degree, the development of distance education cultures. Several academic journals focus exclusively on distance education (e.g., *The American Journal of Distance Education*, *Journal of Distance Education*, *Distance Education*, *Open Learning*, *Open Praxis*). While such journals can provide more timely discussion of issues than books, the matter of developing distance education cultures is rarely addressed explicitly.

Literally scores of books have been published on distance education in general, while other books focus on specific applications such as various forms of teleconferencing (e.g., Duning, Van Kekerix, & Zaborowski, 1993; Hansell, 1989; Olgren & Parker, 1983), computer conferencing (e.g., Harasim, 1989; Hiltz & Turoff, 1993, Mason & Kaye, 1989); Rossman, 1992), audio conferencing (e.g., Monson, 1978), and video conferencing (e.g., Hakes, Sachs, Box, & Cochenour, 1993).

Linking for Learning was the first broad-based publication addressing distance education in K-12 settings (Office of Technology Assessment, 1989). The K-12 literature includes journals of two types: one type focuses exclusively on a particular facet of distance education (such as *Telecommunications in Education News*), while the other type mentions distance education as part of a more general education focus (e.g., *Technology and Teacher Education, The Computing Teacher, Journal of Teacher Education, Teaching and Teacher Education*).

Technical literature abounds with information about telecommunications, the Internet, and video conferencing in such publications as *Wired, On-Line Access, Connect, PC Computing*, and *TeleConference*. Even popular literature has recently inundated the public with articles about distance education and the Internet. For example, the July 12, 1994 issue of *Business Week* was devoted to "The Information Revolution," *Time* magazine's front cover story of July 25, 1994 was about the Internet, and the July 11, 1994 issue of *Fortune* was entitled "Managing in a Wired World." In addition, *Scientific American* frequently includes articles about distance education.

Groups

Another major influence on the development of distance education cultures comes from interactions within distance education associations, organizations, and conferences and other professional meetings. On an international scale, the International Council for Distance Education, for example, holds a conference every two years in different parts of the world. Annual distance education conferences in the U.S. are sponsored by the University of Wisconsin-Madison, Oregon State University, the University of Maine-Augusta, and more recently Texas A&M University. The Pennsylvania State University sponsored the first International Distance Education Conference in June 1994. The International Society for Technology in Education sponsors conferences (in addition to providing special interest groups, services, and materials), the Canadian Association of Distance Education holds annual conferences, and the Open and Distance Learning Association of Australia sponsors conferences, workshops and seminars.

Individuals

Cultures of all kinds are created and communicated with and by colleagues, peers, friends, and relatives. Some examples help to show how peer pressure is already at work in distance education cultures.

On a BBS, for instance, it is generally considered to be good manners to sign messages that you post. Also, there are proper ways of extracting messages when one wants to comment or reply. Peers penalize each other online when conventions are not observed. For instance, participants in online discussions who simply rehash the issues or offer a "Me too," may receive countless messages indicating that they are idiots; or they may receive mail bombs (enough junk mail to keep them busy for days cleaning out their online mail boxes).

Status in a BBS can be gained by establishing oneself as an expert able to answer questions posted online and to answer them concisely. Long diatribes or emotional outbursts are considered inappropriate in this emerging culture. This culture, like most, grants higher status to members who spend the necessary time interacting with others in the culture and thus learning its mores (Paul Jones, personal communication, November 16, 1994).

Computer-mediated Communication (CMC)

CMC, a relatively new genre, serves as both a delivery system of instruction and a forum for discussing distance education. With the proliferation of listservs, electronic journals, and news groups—and with increased access to the Internet worldwide—information and ideas are exchanged electronically within seconds. As evidence of this proliferation, Ellsworth (1994) maintains an online directory of over 100 listservs and online journals about distance education and/or adult education alone. For those more interested in K-12 distance education, the online offerings from a variety of resources on the Internet are increasing at a mind-boggling pace.

Two examples of what is being circulated online about developing cultures in distance education include a listserv message requesting information about the do's and don'ts of video conferencing in higher education (Coventry, 1994) and an online journal article entitled "Teaching via Compressed Video: Promising Practices and Potential Pitfalls" (Bruce & Shade, 1994). As these examples illustrate, educators use online resources to pose their questions and describe their experiences, both of which evoke replies and lead to shared cultures of distance education.

People who want to learn the conventions of a particular listserv or BBS often do so by "lurking," or observing the style of online interactions, before posting their own messages. Many CMC conventions are also available by File Transfer Protocol (ftp) in such guides to the Internet as *Zen and the Art of the Internet* and *An Incomplete Guide to the Internet*. "Netiquette," or network etiquette, generally includes specific guidelines such as length of messages, use of the subject line, replying to messages, using upper and lower case type, signing messages, and quoting passages. Two other conventions that are becoming more familiar are acronyms and "emoticons" (icons representing emotions) in text-based environments. Examples of acronyms are BTW [by the way] and IMHO [in my humble opinion] and of emoticons are :-) [a smile] and :-([a frown].

In summary, the four sources of influence described above have not addressed the construction of cultures in distance education. While random descriptions of developing cultures of distance education exist within the literature, in groups, and between individuals, the most consistent source of culture-building seems to be CMC itself. This paper, written as both a paper and a conference presentation, is an attempt to make explicit the discussion of constructing cultures in distance education to an organized group.

People come together in the above described social environments to construct the cultures of distance education. As we begin to agree upon what works and what does not work, certain behaviors will become conventional. We do not propose a set of established conventions here. Conventions will evolve from within the cultures of distance education.

Summary and Conclusions

A constructivist worldview includes the belief that culture is created by groups of people who develop conventions about how they relate to one another. The newness of distance education formats makes it likely that cultures have not been fully developed and that participants either will be unsure of how to act or will act in ways that are inappropriate or ineffective. The interactive nature of the newer technologies makes it even more important to be deliberate about the creation of appropriate cultures.

As teachers of teachers and of future teachers, we have the opportunity to help create useful cultures by using distance technologies in the classes we teach. By modeling appropriate conventions and making explicit what those conventions are, we are preparing teachers to create useful cultures with their own students.

One approach to helping create cultures is to be aware of what other persons are saying and doing about the creation of cultures in various technologies. Those persons speak through publications of various kinds, the deliberations of professional groups, the actual interactions among those who use the technologies, and conscious culture-building efforts in computer-mediated communication.

The ideas presented in this paper lead to several conclusions. While culture is usually thought to develop over time without much conscious attention, the rapid growth in use of distance education technologies means that a more rapid and deliberate development of cultures is needed. Because there are multiple cultures in distance education, the strengths and weaknesses of different technologies and the differing purposes of interactions make it impossible for one set of mores to fit all situations.

A teacher who wishes to have a useful, comfortable climate for interaction and learning will do well to remember that all culture is created by group negotiation and not by authority's fiat. Such a teacher will devote learning time to group interaction around issues of culture building, knowing the issues that are at stake but giving participants room to negotiate the conventions that will best accomplish the purposes for which the group is formed.

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A Look at Communication Patterns on the MariMUSE: Understanding How Children Learn

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There is limited research available on the impact of Internet use in kindergarten through twelfth grade education (Davenport, 1994). There have been numerous discussions on the logistics of implementing such use into learning environments, the content, and the effects on learners of such activities (Dykes & Waldorf, 1994). A virtual community known as the MUSE (Multi–User Simulation Environment) is one activity that provides a network environment that "enables children to practice and enhance basic literacy skills and general knowledge while collaborating with others" (Dykes & Waldorf, 1994).

This MUSE has been introduced as part of an after school program called the Fifth Dimension (5thD) in which students actively work on computers. The 5thD mixes affiliation, play, study, peer work and theorizing through the use of computers as tools to enhance social activity theory (Nicolopoulou & Cole, 1991). In the past, this setting has been used in research and to observe children setting their own goals as they play educational games on computers and as they use electronic mail to interact with other children and adults at varied locations. The 5thD recently stepped into another magnitude of researching social environments and their part in the process of cognitive change by introducing a MUSE called the MariMUSE into this program. The MariMUSE is a virtual community in which the student can create and contribute to their own environment. MariMUSE is based in Maricopa College in Phoenix, Arizona. It is actively used by the Longview Elementary School in Phoenix, as well as, by students across the country. Children voluntarily enter this activity with guidance from a university student who is assigned to the program. These students will become professional teachers and are currently in a teacher preparation program. Within the MariMUSE activity, these students explore a world where they can take on a new identity, participate in role playing activities, and navigate online through a virtual space while interacting with students from across the United States.

This study explores how communication patterns form among students that are using the MariMUSE as an educational tool. Their communication patterns are documented as the students interact on the activity by creating "capture files" which record number of minutes spent online, number of times logged in, number of words used, and types of words used. Conversation theory descriptors (Pask, 1984) are applied to the interactions to more clearly analyze them. Activities are categorized as commands, questions, and inquiries.

The 5thD research program also serves another meaningful purpose. It allows a setting for part of the teacher preparation program. Through the experience of being paired with a public school student as the student proceeds through the 5thD, future teachers develop critical thinking skills, routines, and professional schemata. How these beginning teachers think and the significance of the conceptual development phase of teacher education are important issues (Joyce & Showers, 1980). Field notes are used with these novice teachers to generate questions and reflect on the experiences of a learning setting. An important feature of writing field notes is the feedback that prompts and directs further reflection in the thinking process.

The final part of this study is the examination of these qualitative field notes written by novice teachers working with the third through fifth grade students on the MariMUSE. The novice teachers write field notes about students, teaching methods, interactions, games, and outcomes. These field notes add the perspective of what the teachers think as they participate in the MariMUSE activity.

Method

Subjects

The 11 third, fourth, and fifth grade students in this study are part of a total population of 34, first through fifth grade students participating in an after school program. Eight of the students are in the third grade, two in the fourth, and one in the fifth grade. Six of the students are female and five are male. The ethnic composition of this group is ten Caucasian and one African-American. These students' IQ scores range from 88 to 129 with an average IQ score of 103.

Novice Teachers

As part of a teacher preparation program, the novice teachers referred to in this study are university students completing a field experience for the undergraduate college level course, "Introduction to Teaching." These university students are paired with specific third through fifth grade students to add consistency in social interaction within the 5thD setting.

Graduate Students and Site Coordinators

Two graduate students coordinate and manage the 5thD site. They are in charge of transportation to and from the site for the elementary education students, making sure the computers and networks work, and creating the atmosphere for collaborative learning to take place.

Instrumentation

To encourage reflection and sharing inquiry into experiences, field notes written by the novice teachers on students, teaching methods, interactions, games, and outcomes are sent on electronic mail to the graduate students, the "Introduction to Teaching" instructor, and to the 5thD archives. The field notes are written in two parts: 1) general site observations, and 2) a narrative describing everything that happens with the assigned student and the novice teacher during one period in the 5thD. The graduate students assigned as site coordinators also write weekly field notes which consist of general site observations of both students and novice teachers.

Procedures

The concept of the MariMUSE is explained to the novice teachers and to the students. They are told that each student needs to try the MariMUSE during at least three sessions. A task card, similar to others in the 5thD describing available games to play, is created. An explanation of the MariMUSE and instructions for logging onto the VAX system and the MUSE are listed. Directions for beginner, intermediate, and advanced levels of play are also on the task card. During the first session for each student and novice teacher, the site coordinator guides them through the task card instructions at the beginner level. Additional play on the MariMUSE is completed by students and their assigned novice teachers.

Results

Student Use of the MariMUSE

The students logged onto the MariMUSE an average of three times spending an average of 35 minutes per session. All descriptor words were commands. There were 21 different commands used such as whisper, examine, edit, link, and create. The students averaged using 38 words per session and ranged from using as few as 22 words to as many as 63 words per session.

Field Notes

Many emotions were expressed in the field notes describing the MariMUSE, ranging from confused and overwhelmed to enjoyed and anxious to learn more about it. This range of emotions was expressed by some in individual sessions. Others experienced this range over more than one session. All participants, except one, described both negative and positive reactions to this activity. The final participant described the activity as only positive.

We found that the knowledge and interest level of the novice teacher had a direct influence on the success or lack of success of the students. Once the novice teacher was given an opportunity to learn the MariMUSE, positive comments increased. Notes such as, "...but once you get the hang of it, it is great" were written by four of the novice teachers. This enthusiasm for the MariMUSE was a definite factor in the reaction of the student. When the novice teacher wrote field notes such as "I am confused and he is also," the notes that followed were complaints such as "he wanted to do something that was easier and had pictures." And the opposite also occurred. One novice teacher wrote, "The more I pump Desiree up, the more her excitement grows."

Another phenomenon was also noted in several observations. Two novice teachers wrote that they had to increase their interactions with their students and with other novice teachers to be able to use the MariMUSE. Learning this activity in isolation was very difficult. One comment that suggested this learning together was, "we began to brainstorm about a unicorn who lost her magical powers when a wicked witch cast a spell...we did not finish, but...that will be the task on Wednesday."

Other written observations included: two novice teachers who listed typing as a concern, there were too many instructions needed to begin the activity, guided tours were necessary, one student did not want to interact on the MariMUSE with children she did not know, one student was described as "loving and enjoying the MUSE...and he loved these computers because of their keyboards", and it is hard to believe that people automatically get the messages we type on the computer. Two of the novice teachers have already signed up to repeat the 5thD experience for another semester. One novice teacher is reconsidering the field of teaching, expressing great concern for her ability to interact with children.

Discussion and Implications

The implications of knowing how children are communicating on the Internet, specifically the MariMUSE is an important body of information. Additional data needs to be collected to better analyze communication patterns. The specific amount of time, commands and interactions by the students is well worth noting. The major impact of this research, however, rests in the interactions and observations noted by the novice teachers when interacting with children on the MariMUSE.

The MariMUSE provides a setting for novice teachers to interact with children and other teachers to increase their socialization. In this setting, they work together to problem solve. Several comments suggest that the novice teachers would like to get advanced training on the MariMUSE before they work with children. This will be tried in the future, but it may have drawbacks. Many valuable observations are made when novice teachers try to understand their own reactions to the activity along with understanding the activity from the child's point of view. This sharing of enjoyment, frustration, and lack of understanding needs further exploration. In this study, it is viewed as an additional factor that helps future teachers understand the feelings of their students as they are learning. The question becomes, should teachers only teach what they know or can they effectively teach by facilitating learning, both their own and their students. The definition of a teacher may need redefined in the electronic world to "a facilitator of learning rather than a disseminator of knowledge" (Maryland State Board of Education, 1994).

Another important part of teaching was expressed by the novice teachers in this study. Enthusiasm was seen as an important variable in learning. The more enthusiastic the teacher, the more active the student. The novice teachers range from excited and positive to frustrated and negative. These emotions carry over to the students with which they are paired. Future teachers must realize that they have a dramatic influence and set the tone and the atmosphere for learning.

The MariMUSE adds another piece to the 5thD activities. The novice teachers gave us insightful comments on this activity. Additional research needs to be completed to accurately assess the value of this activity as a learning tool and the strengths and weaknesses of a virtual reality setting in a learning environment.

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Throw Me a Rope: A Distance Learning Faculty Guide

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Teaching in a distance learning environment can be likened to a person learning to swim. The novice swimmer may be an exceptional athlete, accomplished in other skilled activities like tennis or basketball, but the novice feels panicky when entering the water. The feel of the water is something new and the strategies that worked so effectively when navigating land do not work. The novice doesn't know how to maneuver successfully in this unconventional environment. Without instruction, s/he may flail violently in the water, valiantly trying to stay afloat, but sink because s/he lacks the knowledge of swimming technique in order to stay atop the water. Needed is the "rope" of faculty development to prepare both students and faculty to "stay afloat" while engaged in distance learning.

Teaching in a distance learning mode may promote high anxiety among novice distance learning faculty who are otherwise experienced, accomplished instructors. Institutions of higher education often do an exceptional job of providing the hardware and software for distance learning, but ignore, or pay only lip service to, the necessary prerequisite instructor preparation. Preparation is necessary to assure a successful learning experience for students and a positive teaching experience for the instructor.

This paper explores the preparation of faculty to teach at a distance. We examine the experiences of three faculty members and the evaluations of one undergraduate and two graduate classes who experienced distance education for the first time. We conclude by proposing suggestions for effective teaching/learning in distance education.

The Problem: Taking the Plunge

The experience of preparing for a televised class is frequently accompanied by feelings of anxiety. "Television" here refers to interactive compressed video, which entails a classroom studio and one or more distant sites which enjoy 2-way audio and video linkages. Fear of this new teaching medium is natural but can be an exceptional motivating factor for a faculty member to explore new techniques for teaching a class. In other words, preparing for distance teaching can shift our self concept from being a content specialist to being a methods novice. As Hirth (1993, p. 24) notes, " ...faculty are probably not waiting in line to sign up to teach a distance learning class." Since we are swimming instead of walking, we confront a new challenge, which may be a bit frightening. We recognize that preparation for distance education is an evolving process requiring a number of experiences and revisions, and the task is not accomplished after the first attempt.

Consequently, this experience of planning and teaching a distance education class results in opportunities to revisit the teaching/learning process, employing current learning theory to improve instruction. In the past, we may have lectured, assigned readings and papers, and tested the students. But these methods may not work in distance education. We need to evaluate our instructional methods and go beyond the standard lecture/discussion/test methods with some modifications to adopt a learner-centered approach which will enable each student to learn effectively at a distance from the instructor.

We wish to make a distinction between the instructor who sees this as an opportunity to revisit teaching and learning versus the instructor who sees this as a duplication of the traditional class environment. The latter instructor may simply drag his/her old teaching habits and techniques into the television classroom without adaptation, resulting in the televising of a traditional learning situation. While this instructor may teach effectively in a traditional situation, those effective teaching strategies may not effectively transfer to a distance education environment; likewise, the bad habits that an instructor has also will transfer—and be exaggerated—in a distance education environment.

Traditional Classroom Versus Distance Learning

In a distance learning setting, many of the visual and auditory cues cannot be captured by the technology, and these cues are not experienced by the instructor. As a result, both instructor and students may have a sense of isolation and frustration. Frequently, novice distance instructors ignore this problem, believing that isolation and frustration are the price of teaching and learning at a distance. Unfortunately, when ignored, the affective dimension can overwhelm other cognitive processes, and the learning process can suffer.

To assure a supportive learning environment, the instructor must provide ample opportunity for the learner to interact with the instructor in different ways to compensate for the deficit of nonverbal and verbal cues. The instructor must plan in advance to place the learner, rather than content, at the forefront. As noted above, if the learner's feelings are not attended to, learning may not occur. For some instructors who emphasize content in traditional instruction, the instructor must make a substantial adjustment in attitude, spending more time on the students' concerns. This content-centered approach focuses on "covering" content as opposed to "uncovering" the learners' understanding of subject matter and the learners' interests.

This paper explores learning models which are applicable to distance education and address learners' needs. Using data collected from recent classes taught via distance education, we apply constructivist learning theory to proposed methods for creating effective learning environments.

Theoretical Basis

Learning is not a simple process like pouring liquid into a container. Rather, it is conceptualized as a complex, personal process in which an individual constructs a view of the world. The constructivist view is reflected in an exhaustive review and synthesis of the research literature of psychology and education conducted by the American Psychological Association and the Mid-continent Regional Educational Laboratory (1993). This review outlined 12 principles which may serve as guidelines for the design of instruction and reform of education at all levels.

From these 12 learner-centered psychological principals Wagner and McCombs (1994, p. 3) derived three themes:

> Learners operate holistically as a function of intellectual, emotional, social and physical characteristics;
>
> The learner's behavior is based on his or her perceptions and evaluations of situations and events from a self-orientation that interprets meaning and value relevant to personal goals and interests;
>
> The learner's development across all domains of functioning is never static and unchanging, but is a dynamic growth process that serves inherent needs for mastery, control and belonging.

Wagner and McCombs (1994, p.1) have concluded that research in psychology and education suggest that:

> All learners benefit from instruction in which they are motivated, feel that they exercise control over their learning experience, are respected and are accountable for their own learning outcomes. However, because there is the perception that these variables tend to distinguish distance education learning experiences from traditional learning experiences, there appears to be a greater willingness on the part of distance educators to consider employing instruction designs, models, and techniques to accommodate these variables than on the part of traditional educators.

As Wagner and McCombs (1994) note, current education literature is moving from an emphasis on teaching to an emphasis on learning. Terms like "self-directed learning" and "learner-centered" have new meaning today because of the new capabilities of technology. These terms have been used for 30 years or more but have not been fully implemented.

With this learner-centered approach, the authors engaged in an initial venture in distance learning at their university and collected data which would provide additional suggestions for creating an effective learning environment, concentrating on the affective as well as the cognitive aspects of learning. Our plan was to design distance learning which addresses the needs of learners. We recognized that learning is an emotional activity and the anxiety of the learner and the instructor must be reduced to enable learning.

The Environment

Emporia State University began teaching courses via interactive compressed video during spring semester, 1994. One undergraduate class (13 students) and graduate classes in education (26 students), and in library and information management (25 students) were each taught one evening per week. Two of the classes were taught site-to-site, i.e., the classes were taught from the Emporia campus and transmitted to a remote site 100 miles distant. One class was taught from the Emporia campus and transmitted to two sites, one fifty miles from campus, and the other 100 miles distant.

The director of telecommunication support services worked with each of the instructors to prepare them for the course. Instructors reviewed course objectives and learning activities with the director, attended a teleteaching workshop two months before the semester began, and consulted with the director during the semester the televised courses were offered. At the conclusion of the semester of televised instruction, the director assembled the instructors in the television studio/classroom, and they reviewed the teaching experience which had just concluded. This interview was videotaped.

Other data collected from the semester include course evaluations by students at the conclusion of the courses and two evaluations conducted during the library and information management class. The videotaped instructor evaluations of their experiences were analyzed. All of these data were summarized and analyzed for this report.

Results

Student Evaluations

An analysis of open-ended questions from the three classes (n=64) indicated that students responded positively to the interactive televised classes. Students generally agreed that the facilities and equipment at sites promoted effective communication, instructional materials were considered adequate and distributed in a timely fashion, teaching techniques and external communication with the instructor were adequate, and course content was well organized and applicable to student needs.

Among the criticisms of teaching techniques were the following comments: "Copying information from the screen was difficult. There was too much writing." "The straight lecture style of teaching was difficult to focus on over the TV."

Suggestions included: more handouts, more activities, and open discussions. Several suggestions were similar to the following:

> Three hours of lecture is difficult to stay attentive. I don't know what the remedy for that would be because I know there is so much information to be covered.

Technical problems were a greater issue. In one class, the remote site was criticized by more than half of the students (9 of 16) for not promoting effective communication among students and instructor. Comments identified such issues as an echo in the sound system, hand-held push-to-talk microphones "did not allow open dialog," "the set was lacking technical finesse," the fax machine did not work, no copy machine was available, and technical support from personnel was inadequate. For the campus section of this same class, the remote site was perceived as promoting effective communication; however, one student wrote, "I wonder if the students on the other end really pay as much attention as the students who have the real teacher."

In addition, a few students mentioned difficulties associated with an unsupervised classroom. The following comment about the learning environment was voiced by a few students in two of the classes: "Other students' poor manners and socializing during class instruction [at the unsupervised site] were a problem."

Despite the negative remarks noted above, 50 of the 64 students (78%) agreed that they would enroll in another TV class.

Following are representative general comments about the distance learning experience: "The time saved in travel was wonderful." "At first I was apprehensive about using the microphones then I felt more comfortable." "I love the concept of video-interactive format and enjoyed being a part of the classes that develop this type of learning." "I enjoyed the camaraderie we built at our site. We had some engaging discussions that helped me learn."

These student evaluations were augmented with the instructor evaluations below to constitute our recommendations for distance learning.

Instructor Evaluation

The videotaped interview of instructors was analyzed by the authors and key points recorded. Following is a summary of the findings from that interview. Key issues which emerged were technical preparation, instructor preparation, and student preparation for distance education. Each is addressed below.

Technical Preparation. As noted above in the analysis of student evaluations, technical issues can "make or break" a course. The instructors, like the students, noted the frequent occurrence of technical problems, especially audio feedback, an echoing effect. However, one of the more serious "technical" problems involved no "high tech." The relatively simple distribution of handouts and course materials sometimes became an issue, causing one instructor to completely circumvent the system and to have students deliver course materials to the site.

While technical preparation is a vital component of any distance education activity, we have elected in this paper to concentrate on the two areas of instructor and student preparation, discussed in more detail below.

Instructor Preparation. While attendance at a day-long workshop for teleteaching was helpful to introduce the instructors to the teleteaching process, the instructors admitted that they learned by trial and error. Instructors said that they could not teach effectively on compressed video using the same techniques which were effective for them in traditional face-to-face instruction. Following are suggestions for the preparation of instructors for televised interactive instruction:

1. Preparation for televised teaching should begin long in advance of the actual instructional event. The planning should begin as early as possible, early during the semester preceding the offering of the televised course.
2. A workshop which enables the instructors to experience teleteaching from both the instructor's and student's perspective is recommended. An overview of the teleteaching process and a technical overview of the transmission process is helpful for the instructors to have an overview of teleteaching. This workshop, too, should be early during the semester preceding the televised instruction.

3. Consultation should be provided for instructors as they begin the process of reviewing their course and rethinking instructional strategies. The expected outcome should be the transition from instructor-led delivery to a student-centered approach where the emphasis is upon the interaction of student to ideas, rich in student/student interaction and exchange of ideas. The intent is to provide a dynamic learning environment in which the student is actively engaged in—not a passive recipient of—new ideas.
4. An experienced teleteacher or instructional design specialist should work with the instructor to review course objectives and to revise the course assignments, learning activities, readings, handouts and other instructional materials, and visuals and other instructional media. Learning activities should include a variety of approaches to address a variety of learning styles; for example, in addition to writing a paper, students might be encouraged to prepare a "mind map," a drawing which shows the relationship among ideas and concepts. This activity appeals to students who think and respond to pictures and visual images; it provides a needed alternative to text only.
5. Instructors should examine transparencies prepared for overhead projection and modify them for television projection. While transparencies for projection in a classroom may have numerous lines of text, televised visuals should be limited to no more than five lines of print with no more than five or six words per line. We recommend that instructors learn to use a presentation software package, e.g., PowerPoint, Wordperfect Presentation, Harvard Graphics, or Lotus Freelance.
6. Handouts should be prepared to accompany the transparencies so that students can better concentrate on your message instead of taking notes. Presentation software packages provide for the production of reduced size handouts which duplicate the visuals students see on the television screen.
7. Since student-instructor interaction is somewhat hindered by the television medium, student-student interaction at the site should be enhanced. Instructors should plan for opportunities during each class session for students to interact in pairs or small groups. Such interaction enables students to try out ideas and to participate in discussion before a larger discussion with the instructor via interactive television.
8. Discussion takes longer when teaching at a distance. The pace of the instruction is slowed as the teacher waits for students to gain enough courage to use the microphones and for the video and audio technology to switch to the student speaker. Initially, the change of pace feels awkward and takes some adjustment. As a result, it takes longer to cover content than in a traditional class. The instructor must be prepared to wait longer for student responses because it takes longer for the students to reflect, grab a microphone, and respond. Instead of waiting 3-5 seconds, the instructor on TV must wait 5-10 seconds, or longer.
9. Assessment is important in order to make mid-course corrections to make sure the class in being transmitted effectively. In a traditional class, that assessment is often intuitive (nonverbal), yet with distance education numerous mini-assessments must be planned to make sure there is communication (Angelo & Cross, 1993). In a distance learning situation, the instructor does not have the visual and auditory cues which provide feedback, e.g., the instructor cannot see the look of puzzlement on a student's face or hear the audible whispers or comments which suggest misunderstanding. Neither does the distance learning instructor receive the spontaneous question because students often don't exert the extra effort to pick up a microphone, or otherwise to take the initiative to respond. Students must be trained to be aggressive in calling the instructor's attention to problems.
10. Be prepared for the technology to fail. Have alternative plans if the system is down for a short (or prolonged) period of time. For example, an audio only speaker backup system might be in place.

Student Preparation. The instructor is not the only party needing to modify his/her learning/teaching behavior. The distance learning course needs to be designed and delivered so that the responsibility for learning shifts from the instructor to the students. Added student responsibility requires greater student control and attitude change from being "done to" to being a partner in the learning process.

The following list of ideas may help in this transition:

1. Students must be informed upon registration that the course will be taught using distance learning technologies. Many courses are simultaneously taught on campus as well as at a distance. Studies show that student dissatisfaction with distance learning is greater with the on-campus students than with the off-campus students. The on-campus students may not have been given an option of registering for a traditional or distance class; some of these students may feel cheated or that they are being used as "guinea pigs" in a distance class.
2. Course design must include sufficient time for warm-up social activities as well as an opportunity for each student to use the microphones and be on camera. Student introductory activities may be time consuming but worth the effort in order to assure a worthwhile learning experience. Students at distance sites are separated from each other more than on campus. The instructor must plan for social interaction to build the sense of a learning community. Interactive activities may introduce students to the instructor and allow students to use the technology. These activities can help build a rapport among students as well.
3. During the course orientation period the first day, discuss classroom protocol and appropriate behavior. Establish clear class start and ending times, and a clear understanding of course requirements and expectations. Tell students how to contact the instructor for additional

questions and help. Course logistics are always difficult at a distance and must be given extra care in planning and execution.

4. Establish from the onset the idea that the roles of the teacher and student will change from the traditional classroom. The instructor and student will be collaborators or team members through the learning experience. The students must be shown how this course is designed to encourage their active participation and demonstrate self-directed learning skills.
5. Since interaction among students and interaction between students and instructor is critical to maintain motivation and interest, greater dependence on interactive learning activities must be incorporated into the distance learning course. In order to prepare the students to gain the most from these activities, demonstrations may be planned early in the class.
6. Distance students must be more aggressive in providing feedback to the instructor regarding their learning process and understanding of the content. The instructor must provide a number of opportunities for the students to give assessment information. This approach builds on the concept of a learning team and increased learner responsibility. The feedback methods must be varied to include personal, as well as anonymous, comments. Private comments to the instructor can be made by telephone conferences, fax messages and e-mail messages, while public comments can be handled during the class discussion.
7. A constructivist method of learning has the potential to build greater sense of relevancy and ownership by the students. It also can build student-to-student interdependence and may wean the students away from total dependence on the instructor. A collaborative small group project can also provide the means to address a variety of student learning styles. This approach can build student responsibility for learning.
8. If possible, designate one student to serve as group facilitator to help the instructor adjust the camera and microphones, and assist with distributing and collecting papers. Better yet, assign two students to this task in case one is absent.
9. Ask the students to assist the instructor to honestly evaluate the learning activities used during the course. Teaching and learning at a distance is new to everyone, and all can benefit from constructive criticism.

Conclusion

Recently, the phrase "moving from being the sage on stage toward being the guide on the side" was used during a distance learning conference presentation. This concept accurately conveys the transition a teacher makes as s/he moves from the traditional classroom to the distance learning classroom. In some ways, the distance learning instructor applies his professional skill during the preparation stage of the distance learning course and his socialization and facilitation skills during the execution stage of the course.

Both students and teacher are attempting to use new technologies and new learning skills during the initial distance learning class. Instructor and learner must be patient and flexible and keep a good sense of humor. It will take a number of classes to become comfortable with the new learning environment for both the teacher and the students.

Distance learning may be considered a de-personalized way to teach. Certainly, if traditional classroom methods are used at a distance, the chances of student alienation and separation are increased. Therefore, a special effort must be made to personalize the relationships between the instructor and students. If possible, the instructor should visit each site to personalize the relationship between instructor and students.

Our findings suggest that both students and instructors must be prepared for distance learning. Students expect to be taught as they've always been taught, e.g., lecture, note taking, discussion, papers, exams. Likewise, instructors may wish to teach in the traditional way, using these same techniques. Instead, successful distance learning results from a carefully structured triad focused on the learner: teacher preparation, learner preparation, and technical/logistical support mechanisms. When one of the triad is missing, learning is likely to flounder.

The "rope" of faculty development is needed to help both students and faculty to "stay afloat" in distance education.

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Internet Initiatives for Teacher Education

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Educators are continually searching for new methods and materials to help our youth master specified coursework – helping them gain skills and knowledge that will lead them toward successful and productive lives. In this rapidly expanding world of knowledge, it is essential to provide these students with skills that will assist them to become lifelong learners, able to tap into this knowledge.

Federal, state, local, and other groups have established a variety of initiatives that provide direct or indirect assistance for educators. The six National Education Goals (America 2000) set a standard that expects the nation's educational system to change (improve) to assure that the schools prepare educated and responsible future citizens. To do this, all students must have access to worldwide resources, and this is one of the issues addressed in the federal policy initiatives related to the National Research and Education Network (NREN).

As an example of state activities, Texas has initiatives that address a variety of educational areas. Among them are several technology initiatives: Texas Education Network (TENET), Texas School Communications Access Resource (T-STAR), Centers for Professional Development and Technology (CPDT), Texas Center for Educational Technology (TCET), Regional Technology Preview Centers, The Educational Software Selector (TESS), statewide databases of school library resources, and technology allotments.

Initiatives abound, and teachers must know what these are in order to utilize theme for the benefit of their students. One thing is certain: Learning environments must be created where the student is immersed in thoughtful interaction facilitated by access to 'mindtools' such as databases, hypermedia, and expert systems (Cooper, 1993). In this way, technology can provide the foundation for knowledge construction. "It (technology)... gives us access to vast amounts of information and provides the tools to acquire it, to manipulate it, and to develop insights from it" (Braun, 1993, p.14). Can true change come about without the use of technology in the "Information Age? "... it is unlikely that schooling can be reorganized without broad and careful planning to use current and emerging technologies well" (Hawkins, 1993, p.31). In this way, the effective use of technology can support all of the initiatives.

According to the Random House Dictionary, one of the definitions of 'initiative' is "the power or ability to begin or follow through with a plan or task." Colleges of Education, by encouraging students to become aware of needs, and to develop or follow initiatives that address these needs, will help these future (or current) teachers make valuable contributions to our educational system of the present and the future.

As presented above, technology initiatives are apparent from the local school district technology plans, all the way up to the policies outlined in National Research and Education Network (NREN). The intent of both the legislative and executive branch initiatives is to improve the information, computing, and communications infrastructure for the country's researchers and educators, while at the same time promoting the development of new computing and communications technologies. The government hopes that such efforts will enhance national productivity and competitiveness as well as speed scientific and technical advances in a number of fields. Important features of the Federal government's plans for funding, creating, and managing the NREN include:

1. network linking educational and research institutions in all fifty states in order to facilitate communication, computation, and access to information resources and research equipment;
2. technologies and providing electronic information products and services;
3. for providing networking infrastructure support and information on NREN access and use;
4. advantage of private sector NREN connections;
5. directories, user training, and access to commercial information services—and technology designed to support computer-based collaboration;
6. stored in government databases;
7. mechanisms for ensuring intellectual property protection, assessing and collecting user fees, guiding the eventual transition to commercial use, and maintaining security and privacy;
8. information science, as well as in computing and computational disciplines; and
9. representatives from industry, network providers, and research, education, and library communities—whose mission is to assess Federal initiatives in high-performance computing and communications (Bishop, 1991).

The direction of technology initiatives can be found in many other widely circulated documents. *The National Survey on Telecommunications* (Honey & Henriquez, 1993, p.34), suggested the following five initiatives for the implementation of Telecommunications:

1. Teacher training and support
2. Technology planning at the school and district level which incorporates telecommunications activities into the curriculum
3. Time for professional development and student learning activities
4. Effective assessment measures
5. Phone lines or local area networks

Teacher education has a special set of guidelines. The International Society for Technology in Education (ISTE) standards adopted by NCATE, serve as an effective guide . "All teacher preparation programs must provide fundamental concepts and skills for applying information technology in educational settings" (Thomas, 1991, p. 14) The suggested standards include:

- Demonstrate knowledge of uses of multimedia, hypermedia, and telecommunications.
- Use computer-based technologies to access information to personal and professional productivity.
- Apply computers and related technologies to facilitate emerging roles of the learner and the educator.

A rapidly developing area—the Internet—has much to offer to educators, and is either addressed in, or can provide assistance with, some of these existing educational initiatives. In a recent speech outlining the project, Vice-President Gore (Bagwell & Lucas, 1994) said, "I challenge you, the people in this room, to connect all of our classrooms, all of our libraries and all of our hospitals and clinics by the year 2000" (p. 18).

The Initiatives

Initiatives specifically targeting Internet activities in teacher education will provide a framework through which these programs can receive guidance, if necessary, as they prepare their students to become active participants on the Information Superhighway. Implementation of these initiatives will help prepare future teachers to utilize the worldwide resources that the Internet provides, as they and their students participate in e-mail, Gopher, WWW (World Wide Web), Telnet, FTP and other activities.

The initiatives will focus on technical as well as instructional skills. Technical skills, those that facilitate navigation through the Internet are a must for preservice educators. In like manner, instructional skills must be attended to. Harasim (1993) states that, "Planning and design are key to the virtual environment, just as they are key in the physical environment" (p.25). Good computer mediated communication (CMC) activities promote knowledge networking, knowledge navigating, and peer interaction. Hopefully, the initiatives, along with the suggested activities model this attention to effective planning.

An outgrowth of the implementation of these initiatives will promote future innovation in education. "...new models of learning and teaching are made possible by the assumption that learners and teachers as individuals and groups can interact with geographically and institutionally distributed human and information resources" (Hunter, 1993, p. 42).

Goal

The goal of these initiatives is to prepare educators to become active users of Internet resources, and active participants in the global world of information that is available there.

Organization

The initiatives have been divided into six main categories, the first five of which relate to specific Internet activities, and the last of which relates to Internet access issues. A rationale for each has been presented, to indicate its value and its relationship to the overall goal, as stated above. Each of the initiatives is further divided into levels, based on the type (and depth) of activity.

Level one of each initiative might be included in beginning teacher education coursework, before the more advanced levels are introduced. However, some programs might wish to provide instruction in, and experiences with, each level of one initiative at a time. One or more examples of specific activities that could be used to address each initiative are provided for each of the levels. Activities should reflect real *need-to-know*, situations, rather than artificial (busy-work) exercises. At all times, proper netiquette (etiquette for the Internet) and ethical procedures must be emphasized. These are not listed under the initiatives, for it is assumed that these areas will be discussed and taught at all times.

Initiative One: Online Communications

The first introduction to online activities is often to the use of e-mail, where students communicate with each other, their instructors, other educators, and subject-matter specialists.

Level 1: Personal E-mail. Students might begin by sending mail to each other. An on going assignment might be to send the instructor a reaction to a specific reading assignment. Students might create distribution lists in their electronic address books so that they may send messages to all classmates at the same time. Instructors might arrange for educators (possibly from around the world) and subject matter specialists to communicate with their students on a one-time basis, or for an extended exchange.

Level 2: List Lurking. Students should learn basic listserv commands so that they can subscribe to one or more lists related to their coursework. All students might be asked to subscribe to the same list, or students might subscribe to different lists and send items of interest to their classmates, using the distribution lists from Level 1, or a list that has been established for their class. Students should learn to search the global list of lists, by sending the command *lists global/TopicName* to a listserv, and should be encouraged to find a list that might apply to their other courses. This might also be a good time to introduce newsgroups.

There are many places to find educational lists. One of these, Judi Harris's *Way of the Ferret—Finding Educational Resources on the Internet* (1994), discusses a large number of Internet resources that can be used with this and the other initiatives.

Level 3: Active List Participation. After lurking long enough to determine the types of questions to be asked, students should respond to or initiate at least one query to the list. This should relate to the curriculum of the course, and should be shared with the entire class (If everyone is subscribed to the same list, the sharing may take place through the list, since everyone will see the posts.). After this activity is introduced, it should be required in all classes, to make this an automatic professional activity for these future teachers.

Initiative Two: Gopher Trails and Discoveries

Gopher, as an Internet navigational tool that provides menu-access to a variety of different types of resources, is an excellent introduction to the world of the Internet. Students can find, read, and retrieve files, with minimal difficulty (compared with other means of Internet use).

Level 1: Exploring—With and Without Veronica. Students should be shown how to get into Gopher and how to access help (by typing ?), and should be given a few basic navigational and retrieval commands. The importance of creating Gopher trails (by recording all steps needed to revisit a site) and of setting bookmarks cannot be overemphasized, for these provide students with tangible proof of their triumphs. Students should be given ample time for exploration activities, and a collection of their gopher trails might be shared with each other, other classes, and teachers in the K-12 schools. If they do not find Veronica, they should be encouraged to use it as a search engine, to help them discover the wealth of resources available on the Internet, through gopher.

Level 2: Interacting with the Internet, through Gopher. Students should realize that, when using Gopher, they are actually visiting numerous remote computers. They should learn to discover where they are (by using =), as well as to connect to other gophers (by typing o). Some of their finds will allow them to connect to another computer and use it interactively, for research and other purposes. Students must learn *survival skills* that will enable then to navigate in these systems, getting in, around, and out. Research and instructional sites and activities should be sought, recorded, and shared with others.

Level 3: Retrieving & Adapting Lesson Plans & Other Resources for Classroom Use.

Students will use the above skills to find resources that they can use in their course work, as well as in instruction. They must realize that, for the classroom, Internet resources are like all others. Materials often must be adapted, with consideration for the curriculum as well as student level and interests. Internet resources must meet the same standards as other instructional materials, if they are to be integrated into classroom activities.

Initiative Three: World Wide Web Browsing

The World Wide Web (WWW) is another navigational tool, providing access to limitless Internet resources through the use of hypertext. Selected words and terms serve as buttons which, when chosen, will take the user to more information in that area. There are two different types of WWW browsers (front-end navigational programs). Lynx provides text only access, whereas Mosaic and Netscape allow pictures and sound to accompany the text. Although these graphical interfaces of the latter can provide great instructional support, they are available only to a person who has direct (not phone dial-up, other than a SLIP or PPP connection) access to the Internet.

Level 1: Exploring. The extent to which the student can explore depends on whether they are using a text- or graphics-based program. As students use hypertext to access resources, they should compare this tool with Gopher, examining the differences, and discovering the advantages of each. They should learn to find online help with the program they are using, and master basic navigational tasks.

Level 2: Finding Classroom Resources. This is similar to Gopher Level 3. If possible, text- and graphics-based programs should be used, compared, and evaluated, and advantages of each should be discovered. Access to Mosaic or Netscape must be provided.

Level 3: Creating a Home Page. Students should create home pages for their university and K-12 classes, creating links to other educational resources. Students should work together on the university site, using information and sites from the previous levels, creating a customized resource that will assist them in their future teaching assignments.

Initiative Four: Telnet Travels

Telnet provides a means to login to and interact with a remote computer. Although some gopher resources include Telnet sessions, one advantage of the Telnet command is that it provides direct access to these remote systems.

Level 1: Information Retrieval Activities. Students should learn basic Telnet commands as they access reference and other materials. Suggestions include ERIC, dictionaries, job-banks, etc. At this level, students will be looking for information for themselves, and in support of their university classes

Level 2: Telnet/Classroom Integration Activities. Students will develop activities that integrate these Telnet excursions into the classroom curriculum in their teaching situations. As above, these activities must meet all guidelines for classroom resource selection and implementation. Some of these may actually involve the K-12 students communicating with remote computers.

Initiative Five: FTP Activities and Related Utilities

Although many files are available for downloading directly from Gopher and the WWW browsers, there are many others tucked away in FTP sites worldwide. Students should learn to tap these resources.

Level 1: Finding (Archie) and Retrieving Files [ASCII]. Students must learn to use Archie as a search machine for FTP sites. FTP'ing to the site and downloading simple text files will provide a sense of accomplishment that will help prepare students for the next level.

Level 2: Finding (Archie) and Retrieving Applications [binary], and using them. As students download applications and other binary files, they must learn to decode and uncompress them. This often creates problems and frustrations, and it is essential to provide real activities rather than busy-work, while providing support yet promoting independence.

Level 3: Uploading Files to Share with Others: Once students master the procedures of finding, downloading, uncompressing/translating, and using materials from FTP sites, they may find that they have information they would like to share. Finding appropriate FTP sites and uploading their files, will allow these students, tomorrow's teachers, to contribute to the wealth of resources that are available on the Internet.

Initiative Six: Internet Access Issues

Internet access must be provided for teachers as well as student teachers to allow for the implementation of the activities mentioned above. Connections may be either dial-up or direct access, although the latter should be the eventual goal. Initially, it may be necessary to provide limited access, with connections in the school office, the library, the teachers' lounge, and the computer lab. Ideally, there should be at least one Internet connection in each classroom in every school, with multiple connections where classes may provide access for all students for research and other purposes. Accounts should be available for (and required by) all teachers and student teachers, as well as university supervisors.

The Future

National Education Association senior researcher John Yrechick was quoted as saying, "I really feel this is one of those hinge issues that determines what kind of society we'll have. If schools don't have these resources, then a vast majority of Americans won't have access to this vast new world" (Graumann, 1994, p. 34). The further implication for educational institutions is that this access will only be effective if the teachers in those classrooms use the technology well. As teacher education programs integrate Internet experiences into all courses, they will prepare present and future educators to take their places on the Information Superhighway, finding, retrieving, and contributing resources for worldwide educators. As they then guide their students along the path (with special attention to appropriate use and activity on the Internet), they will take strides toward encouraging global cooperation and understanding, at least in their classrooms.

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Instructional Use of the Internet: Role of Teacher Education

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By now, just about everyone has heard about the Information Superhighway. Just what this superhighway is depends upon who is doing the talking. Telephone companies view this highway as a means of providing some sort of interactivity with your television set. This is also true for cable companies. These companies are seeking a system whereby it will be possible to shop from home by viewing the product and then ordering; it will be possible to pay bills from home; and it will be possible to order from any service that is provided. A person may interact by means of a modem or perhaps with a touch screen to pay bills or to order goods and services. This is very similar to the shopping currently available on television today, except it can be done directly from the screen.

While the superhighway as described above may have some relevance for students and teachers in an educational setting, at the present time there is little discussion taking place in that arena. Instead, the superhighway, as it relates to schools and teachers and students is focused on the Internet. There are a number of schools already connected to the Internet, and many more are getting hooked up each day. The linking of schools with the Internet is one of the fastest growing activities in education today and in many states there are programs in place to insure that all schools will have access.

What is the Internet?

Exactly what is the Internet? In its most basic form, the Internet is a network of networks. The Internet began, modestly enough, by linking university, defense contractors, and the military in a network called ARPANET (Advanced Research Projects Agency Network) in the early 1970's. While it was established to allow researchers to share information, this network was also being used to examine how to maintain communications in the event of a nuclear attack.

The major obstacle to linking different networks together was to find the right protocol. Each network used its own protocol and therefore the computers on one network could not communicate with computers on another network using a different protocol. A protocol specifies how a network will move messages, handle errors, and generally conduct business on that network.

The protocols presently in use were designed in 1974 and are called TCP/IP (Transmission Control Protocol/ Internet Protocol). The use of these protocols allow different kinds of computers to communicate with other computers regardless of type. For example, PCs and Macintoshes can now share the same information. Sun Microsystems and Digital Equipment Corporation computers can talk to each other. All of this is made possible because they all speak the same language – it is called IP.

One of the concerns was how to maintain communications in the event of an attack. That problem was solved by using something called packet switching. Packet switching reduces information in small chunks. This information is coupled with header information related to routing. In other words, it is like putting a letter into an envelope. The beauty of this system is that these packets (information plus the header) would then be sent along the network. It made little difference if all the packets followed the same routing or if they traveled at the same speed. Once the packets arrived at the location they were then consolidated into a unified whole. Two major accomplishments here – packets could be sent by different routes (in the event of an attack, or more probably a breakdown in one of the computers) and speed of the computer was not a relevant factor.

Potential for Classroom Instruction

The growth of teaching and learning activities available on the Internet are increasing rapidly; it would be fair to say that hundreds of new opportunities are presented each week. There are literally thousands of illustrations of how teachers are using the Internet in their classrooms.

One very exciting event that has, and is happening, is that cooperative effort is in existence on the Internet. In the business world, we have heard about quality circles, networking, and focus groups and we are now experiencing growth of cooperative enterprises in education. Although many elementary school teachers have been engaged in cooperative group work for some time, these examples were frequently missing from the middle school and the high school. Today, thanks to telecommunications and networking at the secondary level, the possibility exists for secondary schools to engage in cooperative activities. This theme, of collaboration, is one that is frequently found on the Internet. From simple keypals, to learning based on common interests, to collaborative research the Internet provides a medium for students from around the world to work and share the same research project.

Students, using the Internet, now are involved with keypals from other parts of the city; other cities and states; and other countries. E-mail is the tool that has the greatest usage, by far. Students can do everything from working on one project and sharing the results to actually doing the research together to collaborating on publishing a journal. As a side benefit teachers are noting that students are much more careful in their writing when they are doing so for an audience of their peers around the world. In fact, some students in the US are sometimes embarrassed to note that their foreign friends seem to know English grammar better than they do.

Foreign language teachers no longer need to say "When you get to France (or Spain)..." Now they can tell their students to observe certain usage as they communicate with students in France (or Spain). Through e-mail, and even more through Internet Relay Chat(IRC), students obtain a "real" experience corresponding with other students. Unlike what happens in many of our classrooms, it is not necessary to contrive exercises; nor are they needed. Anyone who has visited a MOO, MUD, or MUSE knows that it doesn't take long to become actively engaged in these "virtual" worlds.

An Internet Hunt that takes place each month provides questions to answer using the resources of the Net. The questions are designed to help students build the skills necessary to navigate the Net. An example of these questions are:

1. When was the most recent earthquake detected by the USGS National Earthquake Information Center?
2. What are the main news items posted by NASA today?
3. There will be a meteor storm in August which will hit the earth. What is the name of the meteor shower?

While not directly designed as academic exercises, one can readily see the academic value of finding the answers to these questions.

There are opportunities for students to ask questions of eminent scientists in the Ask a Scientist section. The U.S. Geological Service has just begun a service where any question (well almost any) related to geology will be answered almost immediately. In fact, one of the most useful parts, and also one of the dangers, of the Net is that students can pose questions about their research or their quest for specific kinds of information. Usually, they get a response in a relatively short time.

There is a place for Dr. Math on the Net and high school teachers have offered the services of their advanced students to answer questions from other students related to mathematics. What a wonderful opportunity for students to assist other students in meaningful rather than "make do" work. Can you imagine the excitement on both sides of the question? There are math puzzles that are sent out each month, with problems at practically each school level. There are journeys to be followed, from people traveling through Antarctica to others going around the world on a bicycle. These people have agreed to log in periodically and respond to questions as well as to describe what they saw.

Even though e-mail is still the most prevalent use of the Net, there are an exciting array of activities teachers can use for almost every subject. Students can and do download pictures and graphics from a wide variety of sources ranging from NASA with its pictures from space to impressionist art. Students can and do practice learning a foreign language through exercises as well as communications with keypals from other nations. IRC also provides for "real time" opportunities to practice a foreign language as well as make new acquaintances. Students can and do engage with other students from all over the world to do research together, to publish magazines and journals collaboratively, to solve problems collectively, and to converse with each other. Moreover, they have the opportunity to access and download a wide variety of documents and research reports that are available on the Net. They can actively engage in activities that are meaningful to them and they are limited only by their imaginations.

With the use of the World Wide Web, we can take our students on virtual tours of museums and various exhibits that exist on the Net without ever leaving the classroom. Have you explored the exhibits on dinosaurs yet? For elementary students there is a "froggy page" that has wonderful songs, sounds, pictures, poems, and stories about frogs. As for the older students, they might wish to explore an interactive frog dissection or one of hundreds of interactive activities available.

One of the ideas for the future is to take students to visit a number of college campuses, of course without leaving the classroom. We can help them examine college catalogues and course schedules. They can literally view some of the buildings and professors. In some instances, they can "go" inside the library. One can tour the Lourve museum in Paris on the World Wide Web, for example.

Role of Teacher Education

Departments, schools, and colleges of education are becoming more heavily involved in issues related to technology. It is true that we have some teachers who do not understand the newer technologies or how to integrate it across the curriculum. Most, if not all, of the teacher education faculty already have the skills they need to use the Internet. The big problem is that they do not know they have the skills. The fact of the matter is that teachers are quite adept at knowing how to access information; they have been doing it for quite some time. What is needed is to help them transfer those skills from a paper medium to an electronic one. Teachers know how to use libraries; they know how to use newspapers and magazines; and they know how to use television and video. Now they need help in learning to navigate the Internet. Once they get excited about any one thing on the Net, they will find creative ways of using it for themselves and with their students.

Faculty Must Model Use of the Net

Today, most, if not all, teacher education departments offer a course or two in computers and other technologies. Too often, these courses focus on teaching the tools of technology; this is not sufficient. Our students need to know how to infuse these technologies into the classroom; not merely how to make a spreadsheet or a database. Schools want teachers who know how to use a database or a spreadsheet in the classroom. In order for this to happen, the faculty who teach curriculum and methods courses must begin to model the use of these technologies in the classroom. Too many of our faculty are not themselves comfortable with these technologies and therefore could not be expected to use them in their classrooms. Yet, all of our students must be given opportunities to interact with all the technologies available today.

Collaborative Efforts

Many teacher education departments have or are seeking to develop partnerships with the public school that go beyond student teaching. There are many public schools where students are collaborating with other schools around the world in collecting information. One project is to have students observe the weather where they live. Another is to have students go to the grocery store and price everyday items like bread and milk. The information, once collected, is e-mailed to the other groups. What a wonderful opportunity to teach analysis and synthesis. We should seek ways to energize our faculty to become more involved with these processes. Where the schools are not doing some of this work, we should seek to find faculty who can assist them in using the broad resources of the Net. As teacher education faculty become more involved, so too, will our students.

Today, we have tutoring systems that are more capable than ever of meeting individual needs. These newer systems are much more responsive to the needs of the individual learner. We must prepare teachers who know how to utilize this aid in working with students. For example, there are computer resident programs where students can explore the world of math, science, or other areas. MIT, for one, has a 24th century space science simulation. We need to make this information available to our faculty and hope they will use it in their classroom. Again, teacher education departments might work with partner schools in making this a classroom reality.

Brave New World

The potentiality of creating "virtual" worlds will have a dramatic impact on how teacher education faculties function. For the first time, we have a technology that has made it feasible for every school, and perhaps every home, to have access to vast amounts of information. We are on the verge of dramatically changing how information is organized, stored, and accessed. The use of hypertext and hypermedia mean we no longer are limited to accessing information in a linear fashion. Instead of merely looking at the footnote, we can examine the research itself. We can literally follow the links as our interests dictate. We predict that student papers, in the future, will be written in hypertext and hypermedia. These will be exciting projects to read and see.

Today, we have the capability of providing students with a much more realistic experience than we have had in the past. A MUD, MOO, or a MUSE offer the potential of utilizing this approach for teaching. Maricopa Community College presently has a simulated school on the Web where students can go into different rooms to do their work. The idea of a virtual school is already here; when it is coupled with virtual reality that will be something else. Even today, hypermedia-based programs allow the student to observe different behavioral incidents in a classroom setting and then select a course of action. Interactive two-way, real time video is currently being used in some schools through software called CU-SeeMe. This software allows for "visits" to the classroom without leaving the campus. What a wonderful opportunity for those teaching the curriculum and methods courses to use live examples to illustrate and demonstrate the points they wish to make.

Given our ability to be interactive via the Internet is it really necessary for every student to be in the classroom in the physical sense? Our students do not need to wait a week until the class meets again to ask a question; we can establish an electronic conference that does not require synchronous attendance. We are both amazed and pleased at the amount of time students will spend in electronic mentoring.

We have the opportunity to provide for all of our preservice students and even inservice teachers a network that can deliver training across the nation. We can help prospective teachers utilize the expertise from teachers in the classroom without having them together physically. We can assist them in having access to their peers and share experiences, aspirations, strategies, materials and ideas. We can set up tele-apprenticeships where prospective teachers can mentor public school students in the grades they might wish to teach.

Faculty

In Michigan, Public Act 335 goes into effect next year. This act mandates that before a student can student teach, the public school must be satisfied that this student knows how to teach with technology and how to use computers. Furthermore, NCATE is implementing a standard that requires college of education faculty to know how to use technology. Some faculty are perhaps convinced that they can make their contribution in a different fashion. We must find some way of introducing these faculty to this changing world. We need to make using technology more rewarding for faculty.

One possibility for assisting faculty to become better users of emerging technologies is to provide released time, on a limited basis, for those who propose to do something to enhance their teaching capability. Perhaps, we might consider allowing faculty the opportunity to submit a plan of action they would take for one semester's released time. If we were to offer this to no more than one faculty member from each program area, we might encourage several people to become more involved with emerging technologies. Were this to be done for several semesters, we would then have a cadre of faculty who would be in a position to assist their peers.

Moreover, as we hire new faculty, we should seek to hire those who not only are knowledgeable in their discipline, but those who are also conversant with the new technologies and how to use them in educational settings. This stance will need support from the administration because faculty who do not value the use of various technologies in the classroom are not likely to hire those who do.

Summary

We are literally on the verge of changing the way we do business, the way we offer programs, and the manner in which courses are taught. Today, it is possible to obtain a college degree through the Virtual Online University without ever having to leave home. Distance learning is here to stay and more of us will be keeping abreast professionally through this electronic medium The prospect of virtual reality will make our professions in the classroom pale by comparison. We can help our students by giving them real experiences as we offer them the opportunity to mentor public school students electronically. We can offer classes online without requiring every student to come to the campus. We can go to them electronically and help bring them the world. We hope the profession is equal to the challenge.

TELECOMMUNICATIONS 2

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Telecommunications: Graduate, Inservice, & Faculty Use

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The tremendous versatility of telecommunications services is one reason why so many teacher educators find them useful. So useful, in fact, that last year the telecommunications section of the Annual was split into two sections: one for graduate and inservice applications and one for preservice uses. This year the graduate and inservice applications section could have been as large as the whole telecommunications section a few years ago. It contains 21 papers but other papers could also have been included. In virtually every section of the Annual you will find teacher educators describing how they are using telecommunications - from preservice programs that teach students about it to faculty development projects that use it extensively.

In some ways telecommunications is taking us in a new direction for personal computing. For most of the history of personal computers their power was in the *box* - that stand-alone computer that sat on your desk and let you do things - word processing, desktop publishing - that were impossible or unbelievably difficult and expensive without that box. That tradition of bringing more and more power to the box on your desk is what made the personal computer industry a multi-billion dollar a year business.

The next wave of the personal computer revolution - telecommunications - has arrived. Telecommunications brings power to you by linking your box with millions of other boxes all over the world. Techies like us tend to think in terms of boxes - machinery and software - but the links are really between the people behind the boxes. Those links - networking, conferencing, collaborating, software sharing, data exchange, and a hundred other types of communication - are redefining what power computing means today. It isn't always the ability to create fantastically complex Lotus 123 spreadsheets. Often it is the ability to collaborate and share with a colleague in Italy, or help a student teacher down the road. That is powerful computing today and the articles in this section explain how that power is being put to work in teacher education programs.

The 22 papers in this section fall roughly into seven categories. The section begins with two studies of communication patterns. Williams and Merideth looked at patterns in a graduate teacher education course while McGee and Boyd investigated patterns in a staff development program.

Six papers deal with the integration of telecommunications resources into innovative teacher education programs. The paper by Kester and Beacham describes a telecommunications program for preservice and inservice teachers that links professional development schools with the university. Linking participants in a teacher education program based on the professional development school model was also the focus of Miller and Robin's paper. McMann's paper has a similar focus. However, instead of focusing on undergraduate preservice teachers and those involved in their training, as Kester and Beacham as well as Miller and Robin do, he describes the use of telecommunications in a post-baccalaureate "hands-on" program. The Common

Knowledge: Pittsburgh project described by Futoran and Wertheimer as well as a project described by Goss are other efforts to serve the needs of computer-using educators (and develop interest in teachers who are not yet using electronic resources). Another project, described by Jones and Harris, connects teachers and K-12 students with "SMEs" - subject matter experts all over the world.

Three papers examined the use of telecommunications in graduate education. Howard and Howard, for example, explain their use of teleconferencing and seminars in graduate programs including a Master's program in distance education. Physical education teachers are the focus of Tannenhill, Berkowitz, and LeMaster's work. Another project with a graduate focus is Schneiderman and Byrne's TEAM project - which involves online seminars and conferences between graduate students using home computers and mentor faculty.

Two papers dealt with integrating telecommunications into the curriculum. Schroeder, Zarinnia, and Griffey described the use of telecommunications and multimedia production that involved students and teachers as well as teacher education faculty and library media specialists. The paper by McManus offers general suggestions for integrating Internet activities into instruction.

Although most of the papers in this section describe the use of telecomputing services, three involve delivery of instruction via television. Beers and Orzech's paper explains the work of the Rochester Area Interactive Television Network that provides instruction to teachers in the region via sophisticated two-way video. Dorward and Trezise's paper explains the use of a T1 telecourse system for delivering distance education that includes two way audio and 8 frames-per-second video.

A few papers describe resources on the Internet that will be of interest to teacher educators and teachers. Troutman, Kiser, and Seifreit's paper explain a lesson plan database on Florida's Information Resource Network. Schultz and Robin report on the development of an electronic newsletter for IT graduate students (and faculty), Jin chronicles the development of tutorial/simulation software for introducing preservice teachers to USENET groups, and Robin, Bull, Becker, and Willis update the status of the Teacher Education Internet Server.

Finally, four papers offer advice, suggestions, and guidelines to teacher educators interested in creating their own telecommunications resources. Leavell and Byrum, for example, take us through the process of receiving a satellite delivered video teleconference on campus. Robinson provides a famework for creating a Wide Area Network to support instruction, and Harris offers sage advice on using and structuring telecomputing tools for professional development and instruction. Baggott, Davis, and Wright, in the final paper, describe the innovative and experimental work at Exeter University on services that can be delivered to teachers and students by teacher educators.

This is a diverse mix of papers that illustrate the vibrant and expansive nature of this field. No one believes telecommunications will become THE ONLY method of teacher education, but virtually every approach to teacher education can be enhanced, improved, or supported by it.

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Internet Outposts: Communication Patterns in Computer-Mediated Classrooms

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As communities have emerged throughout history, they have established outposts—outlying branches or positions—to gain new knowledge and protect the interests of the main group. In such situations, survival necessitated learning quickly, and communication between the outpost individual and other members of the community was vital to solve problems, share information, and discuss ideas. The end goal of this communication was knowledge, a knowledge experienced and refined, constructed socially, tested and applied situationally over a length of time and space.

Today our frontiers are not measured in miles but in time as communication is aided by the wizardry of almost instantaneous electronic transfer. However, the construction of knowledge is still a matter of individuals making meaning of information and their experiences. The constructivist aspect of proactive, interactive learning is supported by cognitive learning theory which focuses upon "the aspects of a situation within which a person and the psychological environment come together in a psychological field or life space" (Bigge & Shermis, 1992). For many students in a formal learning situation, this life space has been confined to a classroom with its constraints and its comforts. As students proceed through the educational system, the environment (classroom) usually operates as a constant, as part of the familiar. It is the ideas which vary, require constructing, and which are the focus of most intraclass communication; that is assuming there is more than one-way communication within a class.

Although most teachers at all levels would report that they use discussion in their teaching, Gall and Gall (1976) have suggested that discussion that is characterized by interaction between students and is related to complex thinking and attitude change seldom occurs in classrooms at any level. Dillion (1984) supports this position by indicating that although teachers report that teacher-student interactions are discussions, most should be labeled recitations because of their reliance on the low level cognitive thinking (knowledge level). Computer-mediated communication (CMC) can alter this pattern of low-level or nonexistent responses because it provides an opportunity to break down the power relationship between faculty and student, and between student and student in a process that Strike (1991) describes as "undominated dialogue." Computer-mediated conferencing *requires* a dialogue for the process to function, but more importantly, it requires a dialogue for teaching/learning. Sproull and Kiesler (1991) report that participants in this type of dialogue develop the ability to use information independently to make decisions and tend to focus on what is said versus who says it. This paper explores the important question of "what is said" by tracing the types of communication over time that students in a CMC situation used to define their electronic classroom and operate within it.

Computer-Mediated Conferencing

The same computer-based communication systems that host computer-mediated conferencing today were originally designed in the 1970s as a type of outpost to transfer data between computers in industry. In 1982, the Western

Behavioral Science Institute (La Jolla, USA) first organized a computer conference in which large numbers of users individually or collectively exchanged ideas (Romiszowski, & DeHaas, 1989). Since that time, computer mediated communication (CMC) networks have grown so rapidly that Locke (1994) estimated that about 40 million people from around the world are on Internet.

Despite the common availability and power of Internet or Bitnet on college campuses, educational programs have not often recognized the possibilities or utilized CMC as a pedagogical component (Carey, Carey, Willis, & Willis, 1991; Sproull, & Kiester, 1991). Using the Delphi technique, Holden and Mitchell (1993) did explore a variety of pedagogical possibilities with a panel of 35 higher education faculty from across the world who actively use CMC. "There was high consensus among the experts that using electronic bulletin boards both to structure collaborative/cooperative student work and to facilitate discussion will become prevalent in the near future." Lauzon and Moore (1989) support this prediction and see computer conferencing as a 4th generation of distance learning with "the potential to deliver both asynchronous individual instruction and group instruction to distance learners." In addition, Seaton (1993) asserts that "CMC, more than any other medium excepting print itself, has been credited with enabling learners to take control of their own learning."

Even with these enthusiastic endorsements of the promise of CMC, its teaching potential must be tested against the reality of active student use and learning. As early as 1987, Harasim has cautioned that "there is as yet very little data describing or analyzing teaching and learning within this asynchronous, text-based environment." More recently, Hawisher and Selfe (1992) have reported the need to investigate the difference between CMC and face-to-face correspondence so that we can "use electronic conferencing profitably for our students."

Context of the Study

This paper is an investigation of students' online communication patterns when their classroom environment has been expanded electronically through the Internet. The 14 subjects of this study were masters-level students at a university in the Midwest. Ten of the subjects were in a Master of Science in Education—Effective Teaching Program, three of the subjects were in a Special Education—Collaborative Teaching Program, and one subject was in a Mental Health Counseling Program. The subjects were exploring the challenging and sometimes confusing area of Research Design in a modified meeting format that spanned six weeks. In the beginning of the course, the class met three times: for eight hours, five hours and three hours within a four day period. The second week the class met two times for eight hours and three hours. For the following four weeks, all communication was via Internet. The subjects and their professor adopted Internet outposts as the medium for continuing group discussion and support as well as consultation on individual research designs as they collectively moved out of the classroom and into libraries and locations throughout the United States. The final class meeting was for five hours at the end of the sixth week of the course.

Students knew before they enrolled that a major portion of the Research Design course was to be conducted via Internet with face-to-face meetings scheduled at the beginning and at the end of the course. All students had prior experience with computers for word processing and statistical analysis, but only one student was familiar with e-mail. The instructor directed students to obtain university computer user accounts (Internet addresses) prior to the first class meeting. The university supported this experiential learning by loaning modems and telecommunication software to students who did not have their own. Alternatively, students could use on-campus computers for their electronic communication.

During initial portions of scheduled class time, the instructor offered Internet skill development sessions. Within a period of approximately two weeks, students engaged in interactive lessons that examined E-mail, Listserv discussion groups, USENET newsgroups, Kermit, and protocols for uploading and downloading files. The class and instructor exchanged all course assignments and feedback electronically (except an extensive literature review). At the end of the course, all students gave permission for the research use of their electronic messages following assurances of confidentiality and each class member's right to refuse permission.

Methodology

The categories of communication upon which this study is based emerged as a result of content analysis of electronic messages obtained from Internet conferencing with a group of doctoral students enrolled in a previous course. From that content analysis, the investigators hypothesized that there is a developmental pattern of electronic communication that Internet novices display which is predictable and a necessary part of the learning process.

To test this hypothesis, we used electronic messages (n = 248) to the class Listserv discussion group (53%) and to the professor (47%) as the unit of analysis. We downloaded, printed, and coded the messages according to the following operationally-defined categories: (a) testing, (b) chatting, (c) assignment, (d) technology questions, (e) content questions, (f) course content discussion, and (g) technology content discussion. Further coding established whether the message was addressed to the professor or to the Listserv discussion group. Three investigators coded the data independently to ensure objectivity. These separate codings yielded an overall interrater agreement of 83%. Within category agreement for four of the seven categories ranged from 80% to 84%. The lowest level of agreement, 62 %, was obtained in the category identified as "chatting." Two categories, "testing" and "technology questions," were coded with agreements of 92% and 94%, respectively. Following coding, we placed the messages in chronological order by date of electronic transmission, determined frequencies and percentages of messages for each category, and identified type and frequency of messages for each of the six weeks of the course.

Approximately six weeks after the conclusion of the course, the investigator who was not the course professor telephoned each subject to obtain post-course impressions of the CMC experience and agreement to complete a written questionnaire which focused on their communication as a group and their private communication with their peers (messages that are not a part of the electronic database). We then analyzed responses to determine selected demographic characteristics, levels of experience with technology, and affective dimensions of their experiences with computer mediated conferencing.

Results

Of 248 electronic messages coded by the seven categories, 196 messages belonged to a single category, 47 to more than one category, two to three categories, and three messages remained unclassified resulting in combined frequencies of the seven individual categories of 296. Figure 1 depicts the number of electronic messages for each category.

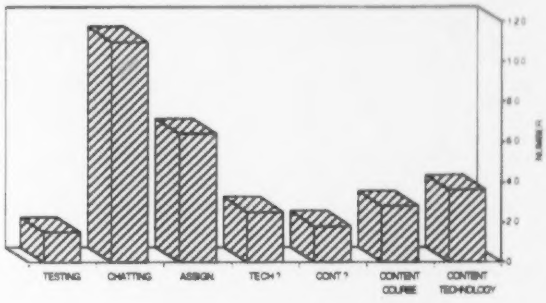

Figure 1. Message Frequency by Category

Over the six week period, the students' messages varied in frequency as well as content. The changing pattern of communication as students became familiar with the technology and each other is displayed in Figure 2.

From the analysis of the electronic messages, a clear pattern of communication by type emerged:

1. Initial **testing** to make sure messages could be sent and received.
2. **Chatting** which began early and lasted at a very high level throughout the course. This type of message ebbed and rose in frequency as students sought and found support at key times (getting started, before assignments, and reinforcing one another when a student expressed frustration).
3. **Technology related questions** and sharing of insights as to how to communicate electronically flowed throughout the early chronological sequence but dropped off as students mastered the "technique." These questions underwent considerable change in sophistication, reflecting exploration and mastery of search techniques on the Internet.
4. Questions related to **course content** tended to cluster toward the end of the course, indicating that once students found comfort in their "space," they were more free to construct knowledge in the usual ways teachers might expect.

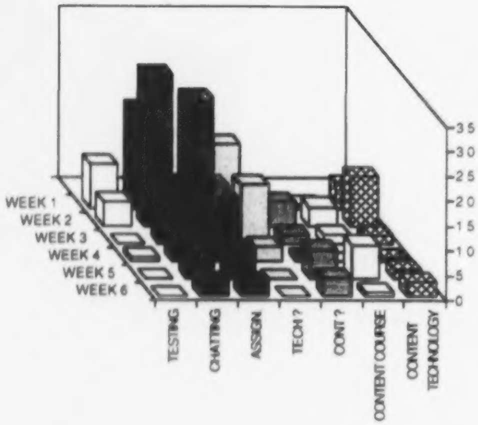

Figure 2. Pattern of CMC Communication

Questionnaire Results

All 14 subjects of the study responded to the questionnaire sent to ascertain student perception of CMC as an instructional tool and as a means of private communication among the students. These students contributed the following demographics to the study:

1. **Gender** = 86% female, 14% male
2. **Age** = 42.86% < 30, 35.71% > 40, mean of 35
3. **Teaching experience** = 42.86% < 5 years, 21.43% 5<10 years, 14.29% 10<15 years, 21.43% <15 years
4. **Previous computer courses** = 71.43% 0-1, 21.43% 2-3, 7.14% > 3
5. **Computer at home** = 86% yes, 14% no
6. **Computers and classroom instruction** = 43% routinely used computers for instruction, 50% used computers for some instruction, while 7% did not use computers for instruction.

The questionnaire covered a variety of items, eliciting different types of responses. Table 1 reports subject responses to specific items of the questionnaire that were ranked on a Likert scale of 1-5. Responses are expressed as percentages with n=14.

Other items of the questionnaire indicated that students not only utilized the network for class discussion and contact with their instructor, but they also engaged in considerable private communication among themselves. Only 7.14% of the students had <10 contacts with other students, while 35.71% had 11-20 contacts, 21.43% had 21-30 contacts, and 35.71% had more than 30 private contacts. These contacts are not among the 248 coded from the public discussion group, but are indicative of the value the students placed upon continuing dialogue. Questionnaire items that verify 86% of the students frequently both initiated and responded to private messages point to the existence of two-way communication. The complexity of that interaction, on the other hand, is apparent as only 14.29% of the students reported that they privately contacted < 5 people, while 64% contacted 6-10 people, and 21.43% reported contacts with 11-13 people.

Table 1. Ranked Survey Items

Item	Low		Med.		High
	1	2	3	4	5
1. Prior experience with E-mail/Internet	92.86	0	7.14	0	0
2. Comfort level with computers	0	0	28.58	35.71	35.71
7. Level of acquaintance with other class members before class	28.57	14.29	28.57	21.43	7.14
8. Level of acquaintance with other class members after class	0	0	21.43	50	28.57
12. Level to which CMC offers an active learning style	0	0	21.43	50	28.57
13. Level of university support for CMC	7.14	21.43	14.29	50	7.14
14. Student perception of technological success with CMC	0	7.14	42.86	42.86	7.14
15. Interest in continued personal use of CMC	7.14	0	7.14	35.72	50
16. Interest in using CMC as instructional tool in own classroom*	0	7.14	14.29	28.57	42.86
17. Overall experience with Internet/CMC	0	0	35.71	50	14.29

**1 response=NA*

Further analysis highlighted one of the strengths of CMC—a variety of times students used the system: 35.72% early morning, 64.28% morning, 92.85% afternoon, 57.14% evening, and 57.14% late night. When students were asked the time they **most frequently** used the system, 7.14% responded early morning, 42.86% afternoon, 21.43% evening, and 28.57% late night.

The ability of CMC to effect changes was mixed. For example, 64.29% of the subjects confirmed that they had changed views about CMC held prior to the course, while 35.17% felt they had not. Students' comments added to this section reveal the positive movement of such a change: "I was able to think through responses and questions before communicating them," and "I was able to find many ways to use the Internet to access info for coursework and my vocation."

Student satisfaction with the experience of CMC was very high (see item 17, Table 1); however, only 28.57% of the subjects felt that CMC had increased their tolerance for ambiguity. Students' comments suggest any new learner's cognitive dissonance: "You must be tolerant to explore and that can be really frustrating," "I think I am just a concrete learner—I don't handle ambiguity well!"

Changes in one's feeling of professional competence moved slightly with 57.14% reporting that they did experience a change, while 42.86% did not experience a change in feeling professionally competent. Comments from students provide insight into this response as they equated "professionally" with competence in their teaching discipline: "It broadened my horizons and put me in contact with teachers all over the world, but I'm not sure it increased my feelings of confidence," "I do feel more competent as a human being, but I don't necessarily feel any more competent in my field."

Open-ended responses from the questionnaire established students' perceptions of the advantages and disadvantages of CMC as an instructional tool.

Advantages

- Opens the door to other educators
- New and interesting information
- Class members develop rapport
- Access at any time of day
- Non judgmental communication
- Limitless resources
- Contact with other parts of the world
- Learning a new technology
- Group problem solving
- Learning from each other
- Enhanced computer literacy

Disadvantages

- Lack of district financial support
- Expanding and changing so rapidly
- Initial frustration of technology
- Too easy to "get lost"
- Inequities due to money & availability
- Lack of equipment

This list affirms earlier studies (Harrington, 1993; Harasim, 1987) even as it balances the ideal—the new, challenging, exciting possibility of unlimited learning and communication—with the very real concern of financing that exploration and maintaining the pace of equipment and information updating.

Conclusions and Recommendations

Results of this study lend credence to the notion that traditional course content and technology for CMC can be introduced concurrently and successfully if the instructor has knowledge of and tolerance for the developmental patterns novices use as they move into a CMC environment. For example, Romiszowski and deHaas (1989) in working with CMC seminars expressed frustration that participants initially required a great deal of reinforcement or they quit, and that it was difficult to keep the main discussion on track. Our data would suggest that instructors delay task-oriented activities and deliberately set up extensive testing opportunities to handle the initial anxiety of the students. Moreover, instructors should encourage rather than discourage the social exchange or "chatting" of the students which, in practice, becomes their support group and enhances participation and student problem solving as in these student comments: "It made me get involved & learn, which I might have put off or not done," "Whenever there was a problem, support was there." It is especially important that students feel free to ask for help publicly so that the resulting discussion can provide a number of alternatives and benefit the knowledge base and metacognition of all the class members.

Other recommendations for the successful implementation of CMC gleaned from this experience would include the following:

1. Clear directions in writing that students may refer to when they "forget"
2. A troubleshooter available through the university computer center or department
3. Equipment arrangements that meet a variety of platform needs
4. Assignments that *require* early and repeated use of the network
5. Timely feedback that positively reinforces the process of CMC
6. Non threatening atmosphere that encourages questions from students as well as answers from student to student

Seaton (1993) asserts that, "As learning is transformed toward a learner directed activity, CMC is likely to become imbedded in this transformation and act as a catalyst toward future developments." As a platform, CMC provides outposts that access unlimited places and information; as a process CMC encourages collaborative learning, independent thinking, and communication of knowledge—a knowledge experienced and refined, constructed socially, tested and applied situationally over a length of time, space, and electronic transfer.

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Computer-Mediated Communication: Facilitating Dialogues

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In the face of new national goals and standards, inclusion, and the integration of technology, teachers face changes in their roles as educators within a field that is undergoing systemic changes (Senge, 1990). Teaching is one field that has all of the critical attributes of a profession but struggles with the identify as a profession, further complicating the evolving roles within the school context.

A profession, by definition, has a focused body of knowledge that is universally accepted and applied within given contexts: a membership system controlled by practitioners and determined by a formal system such as liscensure or certification; and an inherent commitment to those to whom the field serves, placing needs of these clients first (Darling-Hammond, 1993). Although teaching appears to have all of these attributes, teachers have traditionally been treated as nonprofessional bureaucratic workers who are subject to centralized planning and prescriptive instructional practices (1993). Teachers are expected to accept low entry level wages with limited opportunity for advancement. They have limited decision-making power and autonomy and receive marginal status from the community. Teachers typically work in dismal environments with little personal space or standard professional tools and work spaces (Darling-Hammond, 1990).

Within these constraints, teachers are faced with systemic change. Schools are realigning to assimilate national goals, content standards, and technology integration. These changes impact the way teachers teach and interact with others. Constructivism, site-based management, charter schools, the decentralization of administration are all requiring that the teacher become a team member who can look more at the whole and begin to construct the reality of their workplace rather than react to the status quo (Senge, 1990). As professionals, teachers now must contend with a plethora of information, necessitating cooperation between disciplines to achieve continued professional growth and development (1990). Teachers must be able to leave the isolation of the classroom and develop a professional character and the skills required to work with others in collaborative contexts.

Computer-Mediated Communication and Teacher Training

This paper focuses on the utilization of computer-mediated communication (CMC) to provide teachers with new contexts for individually guided staff development and the role of the system operator (SYSOP) in facilitating this process. Using CMC, teachers can discuss their professional body of knowledge and reduce their isolation by having access to other practitioners to collaboratively construct their professional knowledge, skills and expertise. Within the context of CMC, teachers are provided an area of personal work space, autonomous decision making, and professional tools that can be accessed through technology. They can also obtain staff development.

Individually-guided staff development is one of five models of staff development identified by Sparks and Loucks-Horsley (1989). This model is based on teachers' identification of their own needs, setting their own goals, and structuring activities to accomplish those goals. Participating in CMC may be classified as one form of individually-guided staff development.

Research indicates that training teachers by telling is generally ineffective, especially when the deliverer has little connection with the experience or goals of those to whom the message is being delivered (Shanker, 1990). CMC is a selective process in which partners who want to work together do so. Shanker (1990) suggests that "teacher's learning comes through continuous inquiry into practice and integration with colleagues, as well as through exposure to new research and ideas from the academic and broader communities" (p. 93).

From research-based strategies to train teachers, Stallings provides the following advice for effective staff development: "learn by doing... link prior knowledge to new information.. learn by reflecting and solving problems... learn in a supportive environment" (Fullan, 1990, p.6). CMC facilitates all of these criteria. At the same time, the isolation of the teacher is diminished in a manner convenient to her time and level of expertise. Computer mediated dialogues also allow teachers to construct their own knowledge and understanding about technology, the profession and content.

The Electronic Emissary Project

One illustration of this new type of collaboration is the Electronic Emissary project. This project, in it's third year of operation, allows K-12 teachers to identity Subject Matter Experts (SMEs) via a database on the Texas Center for Educational Technology (TCET) Internet server. Teachers search for SMEs who can best help them address topical curricular needs. Once a match has been made, a facilitator (SYSOP) establishes guidelines for the project and acts as mediator, moderator, and facilitator through the duration of the project.

Teachers and their students interact with the SME via electronic-mail (e-mail) to plan and implement a learning experience. All dialogues between teacher and SME and/or students and SME occur within an electronic team account on TCET which forwards messages to participants' e-mail accounts. This allows all interaction to be reviewed and moderated by the SYSOP. The specific role behaviors of the players are determined by need and consensus.

The Electronic Emissary project creates a new context for professional dialogues. CMC as a staff development tool reflects changes in the relationships of those engaged in this learning process. Steeples (1994) notes that rather than the traditional relationship of an expert interacting with an adult learner, alternative relationships are possible within the context of CMC. Because the teachers have no precedence in using technology as a tool for these professional dialogues, the role of the SYSOP becomes critical.

Knowledge about how to assist teachers using CMC as a form of individually guided staff development has emerged from the experiences of the authors as SYSOPs in the Electronic Emissary project and a review of the literature. This analysis focuses on the role of the SYSOP who plays a critical part in the dynamics of the group in a somewhat seamless manner. The SYSOP must be present yet invisible to a certain extent, nurturing and directive at the same time. Not quite a coach or a cheerleader, neither is the SYSOP an expert the way it would be assumed the teacher is an expert in pedagogy and the SME in content. The SYSOP acts rather as a trainer and guide, following the team and intervening with justified intention, a job that requires specific skills, role behaviors, and strategies.

Skills

The research literature dealing with facilitation and moderation skills for electronic dialogues can be categorized into four groups: technical, communication, organizational, and interpersonal.

Technical Skills. Technical skills are those abilities that relate to the operation and organization of resources and functions within a given technical system. The following technical skills provide a resource for the other participants as well as ensure that the interaction flows towards its goal. The SYSOP should:

- *Have a working understanding of the technical operations of the system in which the interaction takes place.* Lack of this expertise can be a barrier to interaction (Steeples, 1994). This includes getting and receiving messages, making changes to passwords and logins, sending files through the system and encoding or de-encoding messages.
- *Know how to search for new and accessible resources on Internet that would enhance the goals of the project.* (Goldstein, 1994). GIF pictures, FTP files, databases and Telnet sites are basic sources the SYSOP should be able to access.
- *Provide technical practice for participants, particularly for novices.* In the Electronic Emissary project this was particularly important since teams corresponded through an account located on a remote server. Test messages were solicited to test the system and demonstrate it's operation to participants.

Communication Skills. The ability to communicate effectively and clearly to participants can prevent repetitive and tedious messages. These skills not only refer to expression, but also to understanding the content of a discussion. The SYSOP should:

- *Provide new participants with any operational/organizational procedures they will be expected to follow* (Hardy, 1992). The SYSOPs in the Electronic Emissary project found that a general overview of this information was referred to by the team members as their discussion began. Although some team members continued to ask questions answered in this overview, most found this gave their discussion direction and a clear foundation for dialogues.
- *Encourage new participants to introduce themselves in an appropriate way* (Alexander, 1994). This may be a brief biographical summary, explanation of why the new member is participating or what they anticipate getting from the interaction.

- *Make regular comments that summarize, compare/contrast or point out themes in discussions* (Honey, 1994, Kerr, 1986). If interaction begins to slow down, questions, comments and reflections on previous comments can trigger new responses (Alexander, 1994, Honey, 1994).
- *Have a basic understanding of the content of the discussion or their contribution will be minimal* (Alexander, 1994). They must develop a vocabulary that relates to the disciplinary topic of discussion (Goldstein, 1994). This does not mean that the SYSOP must be a content expert, but they do need a basic understanding of the topics of discussion and/or the processes of finding answers in that content.
- *Provide opportunities for reflection and accepted opinions.* Vygotsky's explanation of the 'internalization of social knowledge' stresses doing things with others, regular and frequent interaction with others, and discussion about what happens (Weir, 1992). If the facilitator detects dissatisfaction, confusion about content or process, or unwarranted criticism, reflective responses on the part of the moderator can defray, clarify or redirect the discourse through private messages to the originator of the message, if necessary.
- *Engage all participants in online dialogue, setting the stage for collaboration.* This will increase the likelihood that participants will feel that they are becoming a part of the group and thereby be more receptive and adaptive to practices and skills required to be an effective participant (Steeples, 1994).

Organizational Skills. These skills refer to the day-to-day operations of online interaction and relate to the managerial aspects of facilitation. The SYSOP should:

- *Set agendas, determine and assign tasks, and keep the group working toward their goal* (Hardy, 1992). Checking in with updates, summaries, or status reports lets participants know the SYSOP is there and participating.
- *Check mail regularly to respond or provide assistance* (Alexander, 1994). It is also helpful to provide a way in which participants can correspond with the SYSOP or moderator privately.
- *Allow sufficient time to moderate effectively* (Alexander, 1994). Depending on the message traffic, reviewing messages and responding to messages can take more time than a moderator may have planned for. Dedicating a specific time of day that allows some flexibility in amount of time available is also helpful.
- *Develop a personal data management system.* Keeping a log or file folders that contain pertinent information about the participants can help SYSOPs manage communication more effectively. Checklists that remind the SYSOP of activities that need to be done are also useful management tools.

Interpersonal Skills. Interpersonal skills refers to those abilities that help the facilitator understand the participants' motivation and intrinsic needs as well as those social-psychological factors that influence online communication. The SYSOP should:

- *Practice collaboration and cooperation* (Goldstein, 1994). Online discussion frequently focuses on the construction of knowledge which, within a practitioner's context, is dependent on sharing with others (Steeples, 1994). Asking for help, sharing ideas, complementing others on their ideas, or elaborating on ideas are a few ways of participating in a collaborative manner.
- *Provide participants with direct and encouraging support.* An inviting welcome, responses intended to motivate and increase enthusiasm, and critical feedback can give participants confidence and increase their participation (Hardy, 1992).
- *Be sensitive to overt or explicit feelings* (Alexander, 1994). Acknowledging the feelings of participants creates a sense of belonging in a group. If participants express frustration, indecision, or confusion, and these feelings are ignored, continued interaction can be diminished.

Role Behaviors

The electronic facilitator plays many roles interchangeably, typically with unclear norm expectations and few status rituals (Steeples, 1994). This lack of role definition can incite excitement and energy toward the tasks at hand but it can also result in confusion, exhaustion and burnout, particularly on the part of the moderator (Steeples, 1994). Starting with some expectations of roles can alleviate some initial stress for the novice facilitator without constraining the flexibility of roles that a given situation may necessitate.

Three types of role behaviors were identified from a review of literature: moderation, mediation, and facilitation.

- **Moderation** requires defining the context of interaction including time constraints and method of communication (Goldstein, 1994). Modeling tasks, language, and dialoguing strategies, as well as technical procedures are inherent to moderation.
- **Mediation** requires locating resources on the Internet, creating communiqués that reflect status or intention of interaction (Levin, 1994) as well as intervening when group objectives are not being met.
- **Facilitation** requires drawing in participants and allowing them to construct ownership (Levin, 1994). Engaging all participants in the discussion or design of the project also creates an environment for a working group (DiMauro, 1994). This collaborative process can be directed by posing procedural questions that direct discussion efficiently and by providing "intellectual leadership" as the SYSOP serves as a context expert possessing skilled role behaviors (Feenberg, 1986).

It is important to note that research on CMC indicates that role flexibility occurs in many online interactions. In electronic discussions there is a shift from the expert/non-expert hierarchy to a collegial sharing of information and skills (Steeples, 1994). Keeping this in mind, the facilitator/moderator may find herself stepping out of the roles described above.

An example of this shift occurred during one Electronic Emissary team project when the SYSOP became a pedagogical expert. A team working on a math project wanted to motivate students to learn math but did not have a strategy. The SYSOP suggested focusing less on the content of math and the solving of abstract problems and more on the process of math and how mathematicians think and find answers. This focus allowed students to respond to real world problems from the SME's experience and provided them with an opportunity to pose questions of their own.

Strategies

The following strategies are derived from the authors' experiences as SYSOPs in the Electronic Emissary project and a synthesis of the skills and role behaviors described above.

- *Facilitators must provide several levels of support.* In addition to technical support, facilitators may also provide support in interpreting or developing an appropriate disciplinary language used in the dialogue and in helping to develop curricula applications for experiences in the classroom (Goldstein, 1994).
- *Facilitators must help participants define an objective for the interaction.* One established criteria for a successful dialogue is a well-defined objective (Beals, 1992). This statement(s) should operationally define the intent of the dialogue and result in an outcome that can be experienced or observed by all of the participants. Participants should also agree on the criteria that will determine the outcome of the project.
- *Facilitators must be responsible for regularly communicating with the group, especially if communication begins to falter.* Some research indicates that longer messages tend to evoke more responses and response that are more varied in nature (Beals, 1992). Longer analyses of the project might be useful if interaction begins to falter. A restatement of the project objective, along with a summary of what has occurred to that point, and possible future steps, could provoke questions or new ideas from participants. For example, one teacher-participant became silent for weeks after sharing technical barriers and student motivational problems. He did not know how to get students excited about the project. Student behavior tended to support the concept of mechanomorphism, associating perceptions of the computer to the person with whom communication is occurring. The students saw the SME as impersonal and an uninviting source of objective data. The SYSOP began to pose possible strategies for engaging students that the teacher began to discuss with the SYSOP and the SME. Eventually, students began to pose questions directly to the SME, establishing a personal link.
- *Facilitators must communicate in ways that require a response.* Research in online tutoring indicates that Socratic dialoguing can facilitate the construction of knowledge and establish a more self-directed approach to learning (Hardy, 1992). Responding to a message and concluding by posing a new idea, way of thinking, or course of action can prompt a response in the recipient.
- *Facilitators must model standards of interaction.* Modeling the tone of interaction, ways of communicating including introductions, greetings and closures as well as follow-ups helps group members construct their own standards of interaction (Alexander, 1994, Hardy, 1992).

Conclusion

The SYSOP can enhance individually guided staff development in the electronic environment. Basic role behaviors such as mediation, facilitation, and moderation provide a basis for the specialized, context-dependent role that the SYSOP must develop. Individual dialogues may develop unique needs, and the SYSOP must remain open to changing roles to meet those needs. Strategies employed by the SYSOP emerge from the constructed role behaviors and prerequisite skills for successful online dialogues. Successful facilitation can potentially enhance the teacher's professional development as she experiences and refines new knowledge of content and pedagogical skills.

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Interdisciplinary Curriculum Development using Telecommunications

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Many individual teachers carry out innovative projects each year within the confines of their classroom. Often the projects could be different and the ideas expanded upon with access to resources beyond the classroom databases, electronic resources, experts, other inquiring teachers and students. How can schools connect teachers and students around the world and provide access to these outside resources? What new tools can teachers use that provide "relevancy, immediacy, and collegiality" (V. Hrabrich, personal correspondence, May, 1994)? Technology can help provide answers to some of these questions as demonstrated in a Wisconsin school-university partnership to develop interdisciplinary curricula (Schroeder & Zarinnia, 1994)

During the 1993-94 school year, faculty from the College of Education at the University of Wisconsin-Whitewater and 26 teachers and library media specialists from eight schools in southern Wisconsin participated in an interdisciplinary curriculum development process employing telecommunications and multimedia production as tools to actively involve students in their own learning while connecting both them and their teachers to a wider community for exchange of ideas. The project is being continued in the 1994-95 school year with 21 teachers and library media specialists from four schools, two from the first year of the project.

Project Implementation

Goals

A major goal of the project was to encourage teachers to develop activities that would take their students beyond the classroom walls and require multimedia arguments with supporting textual, graphical, sound, and video evidence. By providing access to telecommunications and the resources of the Internet, teachers and their students could exchange and critique ideas, collaborate on projects and gather information from the broader community and resources of the Internet.

A second goal was to foster active learning through investigations outside the classroom, sharing ideas with students at other sites, and creation of multimedia reports published to a wider audience. These activities motivated students by allowing them to explore topics of personal interest, work in their stronger modalities, and participate in cooperative learning groups. Students became publishers of information for an audience, not just passive consumers.

To attain these goals, we developed a program that trained teachers in telecommunication and multimedia technology skills, explored new methods of investigation and resource gathering, encouraged cross-site work, active student learning, and production-oriented curricula. This training was given in the context of three credits of graduate coursework over the two semesters of the grant.

Participants

Nine College of Education faculty members agreed to participate in the grant to varying degrees: two from the Library Media Program in Educational Foundations and seven (five full-time and two half-time) from various subject areas at the elementary and secondary levels in the Curriculum and Instruction Department (C&I). In order to have a critical mass at each school for mutual support, we sought groups of three participants in up to eight schools. In addition, two districts each supplied equipment for one additional individual from their schools. Administrators agreed to install phone lines in the teacher's classroom and provide ongoing support for technology use by these teachers after the grant.

During the first year, the elementary schools showed the greatest potential for student production and the greatest interest in continuing participation, so in our second year we concentrated at that level. The original elementary participants continued in the second year of the project and were joined by seventeen new participants. Three of the original C&I faculty and the two Library Media faculty continued the project.

Hardware and Software

Each participant received a computer, modem, classroom phone line, and mainframe account. An AppleTalk Remote Access dial-up fileserver enabled simple sharing of student products. To facilitate audiovisual (AV) production, we purchased one Quadra 840AV with a StyleWriter printer per school. PowerBooks allowed teachers to take their computers home, on field trips, and/or use them with small groups of students. The same equipment was redistributed for the second year of the project. Faculty set up a listserv so participants could raise issues and resolve problems

Sessions

In the fall of the first year, teams met on campus for three day-long sessions to learn to use the Internet, and the basics of hypermedia production, including the creation of digitized stills, video and audio, and their integration into HyperStudio stacks. Group dynamics strategies enabled members to get to know each other and form cross-site working groups. Participants explored issues related to interdisciplinary curricula such as the quality of artifacts used in the productions and the types of writing that might be used. They began the process of cross-discipline, cross-school curriculum development, which was continued through telecommunications, individual consultations via phone, peer help, an occasional faculty visit to the schools, and three additional day-long sessions during the second semester.

In the second year of the project, two four-hour technology training sessions were held for new participants and the Library Media faculty visited the four sites for additional assistance and training. The focus of these sessions was on telecommunications and hypermedia production with less emphasis on other Internet resources. The faculty also focused on key people at each site to act as liaison and trainer for the rest of the group at that school. In practice, much curriculum development has taken place during technology sessions, and much technology training has been sought during the curriculum sessions.

We encourage participants to be familiar with each other's spaces as well as faces so in addition to the technology training, three four-hour curriculum development sessions were held in rotating sites during the fall semester, with additional work done via telecommunications. One session was held before the technology training to develop group cohesiveness and project ideas. Two sessions were held after the technology training to foster further development of curricula. Additional sessions for curriculum development are planned for the spring, supplemented by site visits by C&I faculty to facilitate the process.

The Projects and Products

A wide variety of projects grew out of the work of six self-selected groups who worked on different thematic units culminating in student productions. Three individuals from two elementary schools 70 miles apart worked through the scientific method with their students by exploring lakes in their communities. They investigated the frozen lakes during field trips — gathering data on water temperatures, ice thickness, water clarity, oxygen levels, and fish inhabitants, shared data through telecommunications with each other, compared and contrasted their findings, and then produced videos, HyperStudio stacks, and newsletters to document and share their experience with their partner school, parents, and the school board. Groups from two high schools explored water use and quality in their communities through surveys and other data gathering techniques. Two middle school classes and an elementary class explored the mechanics of flight. Another middle school group looked at the impact of railroad development on cities in the state. Two middle schools, one from a suburban community and one from an inner city community, got to know each other via telecommunications and then took field trips to explore each other's environs.

Work on the 1994-95 projects is moving beyond the planning stage. One group of primary classrooms, including a bilingual one, has already made a joint field trip to a farm and is working on language skills. The frozen lake group plans to repeat their experiment, but those teachers joined by a few new classrooms have embarked on a project in which their students invent and market new "products" to the other classes via telecommunications, incorporating math, economics, language arts, and marketing skills.

Project Findings

Teacher Needs

Equipment. It is important for teachers to have full-time access to a well-equipped computer of their own in the classroom with immediate access to an outside line and a modem. They also need the choice of portability. Many did much work from home during evenings, weekends and vacations. There simply is not enough free time during the day. One teacher who had a laptop last year and elected to have a Quadra 840AV this year is in a dilemma because she needs the multimedia capabilities of the AV computer, but has now realized just how much work she had done at home with the PowerBook. In fact, several spouses noted that the project was spilling into home life.

It is equally important for each classroom to have a pod of three or four machines. The elementary teachers have been remarkably creative in managing to have many of their students using the computer for either multimedia production or telecommunications. However, a teacher "needs more laptops. [It is] difficult to keep everyone motivated and involved when not actively participating" and "structuring the time to get each student equal opportunity to become involved" is difficult (L. Bartolotta, personal correspondence, May, 1994). In some schools, the participants shared computers so that all three could be used in a classroom at one time. In schools at other levels, teachers did little sharing. Several of the schools acquired additional Macintoshes over the past year to make groupwork easier during the 1994-95 project.

Easy multimedia production is important, as is shared expertise and collaborative problem solving. The 840AVs were invaluable for capturing and digitizing video. In some schools, the person with this computer, often the library media specialist, became the expert and assisted others in its use. In high schools, these computers were less used, as multimedia production was not undertaken to the same degree. In the 1994-95 projects, most of the schools received two 840AVs for multimedia production in addition to having acquired some additional multimedia machines themselves.

Technology Training on Demand. Many expressed a desire for greater depth of technology training and pressed for its inclusion in the second year. However, the pacing of the technology training in the 1994-95 project was actually reduced to accommodate the influx of inexperienced computer users. Participants need to be able to practice with an instructor handy for questions and problem solving. Participants appreciated the ability to call or use e-mail for questions, and some even required personal visits for problem solving. In general, they noted that the "most useful activities were the hands-on, show-me-how-to-do-it activities" (J. Goswitz, personal correspondence, May, 1994). They felt they made great advances in technology skills, but quickly realized how much more there was to learn. "I feel pretty much like and embryo in the seventh week of prenatal development. Maybe one day I might become a fully developed eight week old fetus" (V. Hrabrich, personal correspondence, May, 1994).

Participants from the previous year have acted as technology mentors in their schools. However, Library Media faculty continue to answer questions on-call and make site visits to help with technology concerns. We anticipate this continuing in the spring semester, especially the need to provide more advanced training on-site and as needed. Many technology and software problems encountered during the first year were anticipated in the second year of the program, but new ones continually crop up, especially as the participants become more sophisticated users of the software. Modeling problem solving is required but is valuable, and time consuming.

Curriculum Development Time. In the first year, despite sessions for group work, the listserv, electronic mail and the fileserver, participants still expressed a need for more planning time. In the 1994-95 sessions, the technology training time and curriculum development work were separated, with more time allocated for actual group planning time. Time for computer use with students in the classroom was also an issue, especially with a limited number of computers. Finally, time for the participants to become familiar with the technology and to use it on their own was always at a premium. Time was also a problem for university faculty as all were participating on top of their regular teaching loads. Several decided they could not contribute adequate time and chose not to participate during 1994-95. A more precise division of labor was drawn up for the second year to reduce faculty burnout.

Clear Goals. By its nature, the project and its goals were complex. In the first year, participants began with different expectations. Some came for the technology training and had little interest in interdisciplinary curriculum development, especially some of the high school teachers. Of those, some were interested solely in telecommunications. This was reflected in the intra-group actions and productions. Whether the cause is scheduling or academic disciplines, high school teachers have difficulty finding the opportunity to interact with teachers outside their discipline. Not every school came out of the first year of the project with a secure cohort group of colleagues to support each other in technology use.

In the second year, the goals of cross-site, interdisciplinary curriculum development, with collaborative student investigations and student multimedia production were expressed even more strongly to potential participants. We also elected to focus at the elementary level because interdisciplinary work is much easier for elementary teachers than for high school faculty. Some high school faculty doubt the integrity of interdisciplinary curricula.

Teachers' Growth

Roles, Skills and Perceptions. The effects went beyond mere skills. Some participants will conduct technology inservices in their own schools and share their enthusiasm and knowledge with others. Others have become technology mentors for their colleagues. For many it changed their view of themselves as educators. "It can and has become an integral part of my professional life. It offers the teacher more opportunities to collaborate with other professionals. It opens a variety of avenues to pursue. For students it can do the same" (T. Mocarski, personal correspondence, May, 1994).

Funding and Grant Development. For many it provided an awareness of what was possible, and prompted further action. For one, it helped the funding of a multimedia station for teacher use (A. Carroll, personal correspondence, May, 1994). A teacher at another school wrote a $700,000 grant proposal to NASA that "wouldn't have happened without this project" (L. Buescher, personal correspondence, May, 1994). The project sparked development of a technology plan for another school in consultation with other faculty followed by contacts to Ameritech and Apple for wiring ideas and possible grant sources. This project made technology very visible in the school. As one participant said, "Now we can see the possibilities and feel charged to move forward" (C. Guszievski, personal correspondence, May, 1994).

Presentation to Peers. As teachers realized that their students' efforts and their own collaboration was a matter of interest to parents administrators and board members, they gained confidence and excitement. It is remarkable how diffident they were at the thought of sharing their ideas with a broader audience. However, some have now made presentations to an enthusiastic statewide technology audience and are enthusiastically preparing to present their interdisciplinary project and their students work to a national meeting.

Students' Growth

Investigation. Students went beyond their classroom walls to collect data. One middle school group created a HyperStudio presentation on the growth of cities in Wisconsin using library resources to get data on the growth of cities and then creating cards for each decade to present the data. They used this to look at causes for rate of growth (M. Endress, personal correspondence, May, 1994). A high school group collected video segments on signs of history in their community and then created a stack for presentation (C. Gusz기ewski, personal correspondence, May, 1994).

Multimedia Publishing. Students learned that projects can go beyond the written word both at the elementary and secondary level and developed skills in presentation of their ideas. "Kids in my class enjoyed this experience and learned concepts (well) of writing to an audience, effective wording for communication, variations and creativity in presentation of information, and that this world isn't such a big place when you're on the Internet" (L. Bartolotta, personal correspondence, May, 1994). [My students used HyperStudio for] "note-taking, information gathering, direction writing, entertainment, drawing." [They captured and digitized images] "as part of report writing to communicate with other students and parents" (R. Kamps, personal correspondence, May, 1994).

A Broader Audience. Students saw that their work was of value to others and learned to write for specific audiences. "We had students at our school sites send math challenges to each other on a weekly basis using e-mail" (E. Gonzalez, personal correspondence, May, 1994). A joint middle school, elementary school group created stacks on how to build a hot air balloon and a tetrahedron kite that were sent to other schools to see if they could build them. They then conducted experiments using the balloons they built (M. Rohlfing, R. Kamps, & E. Gonzalez, personal correspondence, May, 1994).

Equity. "In schools where a large number of the population is a diversity of minorities [telecommunications] opens up the world to them. They get out of the ghettos through the airwaves of telecommunication connections" (E. Gonzalez, personal correspondence, May, 1994). "The project truly promoted understanding between the inner city and suburban students who participated. Our project involved the creation of a HyperStudio stack that allowed the students to share their knowledge collaboratively in ways that I would have never imaged possible before this class" (M. Endress, personal correspondence, 1994). But technology also has the potential for segregating students, "Such telecommunications opportunities will probably be available to the elite first" (E. Gonzalez, personal correspondence, May, 1994).

Where Do We Go From Here?

Short-term projects can only hint at where we go from here. However, one of the most exciting aspects for faculty was the creativity, initiative and professional growth of teachers who had equipment, support, training, a few clear goals, but no detailed prescriptions and directives. Equally exciting was the enthusiasm and motivation of students when offered significant investigations, alternative modes of expression, different venues of operation and real audiences. Nevertheless, quality of student project design, evidence, and expression evolved into a matter of real concern and reflection. We observed students presenting their projects with justifiable pride, but obviously in need of additional help with technology and unfamiliar presentation skills, and with greater attention to the technology than to writing. In the first year, we observed projects that were a major advance, but which could be made much better. We need to reevaluate to see what we can do to enhance the design of investigations, to promote the collection of high quality evidence and to further skills in creative, convincing, and authoritative expression of an argument. Finally, we need to continue to support students and teachers in addressing wider audiences about investigations, issues and ideas of importance to them.

Financial and Grant Support

The project was funded in by a $124,000 grant from Ameritech; tuition fees from the school districts or individuals for the three-credit course; overrun costs for phone installation and usage as necessary from districts; technical consultation from Apple Computer. In-kind contributions from the College of Education included additional multimedia equipment and facilities for training, Internet access, phone line installation, and use at the university, kickoff and ending dinners, and other miscellaneous expenses.

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A Model for Inservice Teachers, Preservice Teachers, and Methods Faculty Learning to Drive on the Information Highway

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Universities and public schools must work together to prepare preservice and inservice teachers to use the technologies of the 21st century. The Model Clinical Teaching Program (MCTP) is a three-time national award-winning teacher development program collaboratively designed and implemented in North Carolina by East Carolina University (ECU) and Pitt County Schools. One of the MCTP's objectives is to develop ways to use technologies to improve the ways we teach and learn.

There is no disagreement in the literature that teacher education programs should provide technology training. In 1983, the Elementary and Secondary Schools subcommittee of the Association for Computing Machinery Education recommended a special course for teacher education (Association for Computing Machinery Education, 1983). The report by the Office of Technology Assessment (1988) identified teachers' lack of training and limited access to computers as a primary barrier to the infusion of computers into the instructional process. Progress has been slow and it is discouraging that student teachers have few opportunities to see the use of technology during their field visits to schools (Sheingold & Hadley, 1990; Bosch & Cardinale, 1993).

How much training and how it is to be incorporated into teacher preparation is still under discussion (Bosch & Cardinale, 1993; Descy, 1993; Ingram, 1992; ISTE, 1993; Strudler, 1993). Sustained practice and staff development are essential yet are too often omitted from the integration of technology into classroom instruction (Sheingold & Hadley, 1990). One model for training disperses the technology into 11 courses taken during the final year of preparation (Todd, 1993). Other models focus on the diffusion of innovations literature (Hamilton & Thompson, 1992; Harris, 1994).

Building on the findings from the research literature, East Carolina University School of Education and the Pitt County Schools have developed a unique approach to meet the needs of preservice teachers, inservice teachers and methods faculty simultaneously. This staff development project focuses on the what, how, and why of technologies, with an emphasis on telecomputing, as they relate to classrooms, both in the public schools and at the university.

The first phase of the technology plan is the use of telecomputing, including electronic mentoring and electronic peer coaching, as a technique to enhance the professional growth of preservice and inservice teachers, administrators, and university faculty. The second phase of the technology plan is the use of technology as a tool for investigation and decision making to enhance the intellectual development of elementary students. The plan uses a shared equipment, software, and technical expertise approach to construct easy "access ramps" to the information highway. The plan also uses a shared electronic problem solving staff development approach to provide "road maps" for highway use.

Background

The Model Clinical Teaching Program at East Carolina University is an innovative model of teacher development that brings together preservice and inservice teachers, administrators and university faculty for a year of inquiry, experimentation and reflection. Building upon the four cornerstones of Partnership, Internship, Mentorship and Leadership, the MCTP has constructed a new design for teacher preparation, growth and renewal. This university/public schools collaborative continuously explores ways (1) to create a support environment for the professional development of all educators, K-University and (2) to define, clarify and refine the art and science of teaching and learning (Beacham, Thomson, & Misulis, 1992).

The year-long internship provides extensive opportunities for preservice teachers to integrate their university coursework into the context of a public school classroom, maximizing the benefit of applying theory in real learning environments. The preservice teachers in the program, known as interns, begin their senior year at the same time that the public school teachers begin their school year. In August and September, they perform "mini-teaching" tasks, assisting their teacher, known as a clinical teacher, in a variety of non-teaching, group, and individual activities. Beginning in October, interns and clinical teachers team plan, team teach, and team reflect. Interns continue to assume more responsibilities to the end of fall semester. By January, interns are performing all responsibilities as the classroom teacher, with the clinical teacher acting as guide, coach and facilitator.

Working closely with their clinical teachers, interns explore all facets of the school organization and roles of a classroom teacher. Operating as a cohort group during the year-long experience, the interns are encouraged to explore all aspects of professional development. This approach provides an invaluable source of networking, problem solving and collaboration. The networking concept extends beyond graduation, providing support for MCTP graduates as they become beginning teachers (Beacham, Rikard & Knight, 1994).

The MCTP's mentorship pairs each intern with a clinical teacher in an extended growth relationship. All clinical teachers work together to create a supportive learning environment in which interns and clinical teachers together examine and reflect upon belief systems, curricular and instructional practices. The clinical teachers have received and continue to receive special training in seminar settings that allow them to examine, discuss and reflect upon the process of teaching and learning, instructional decisions, mentoring practices and issues critical to quality education for all children (Rikard and Beacham, 1992).

A site based management team, composed of a representative from each of the six participating schools, the methods professors and the program director, oversees the implementation and annual evaluation of the program. Based upon the feedback of all participants, the team develops the revision plan for the next year. In April, 1992, the consensus of all MCTP participants was that the MCTP curriculum must be revised to include technology. This paper describes the development and implementation of the MCTP plan to integrate technology into the existing methods courses and to train MCTP "drivers" to be successful travelers on the information highway.

Project Design

Phase One: Needs Assessment - Personnel and Fiscal

Personnel. A study conducted in the early fall of 1993 to examine the interest and use of technology by the clinical teachers revealed that general interest in using technology was high; however, responses indicated that 14 of the 21 (67%) had never used telecomputing either personally or in teaching. These data provided the beginning point for a staff development plan which provides experienced teachers as well as university methods faculty with the personal skills to use the technology tools of learning that are now finding their way into the schools (Kester, 1994).

Fiscal. To complement the personnel needs assessment, an assessment of the facilities and equipment was made. The Director of Media Services of the Pitt County Schools, with the assistance of Dr. Diane Kester, educational technology faculty team member, prepared a plan for the acquisition of equipment and software for telecomputing workstations in the schools. The plan included the installation of telephone lines and the purchase of modems and communications software. An inventory of the computers in each school identified which schools had an available computer and which schools would need an additional computer to be supplied from surplus from the university.

Phase Two: Implementation and Staff Development

Implementation: Building the Acces Ramps. In the spring of 1994, the Pitt County schools installed a telephone line in each library media center. This line was to be shared by telefax and telecomputing applications. The school system purchased modems and telecomputing software, *Pro-Term*, for those sites using an Apple IIGS computer. The university provided telecomputing software, *ProcommPlus*, for the MS-DOS computers that were placed temporarily in the schools without another computer available for telecomputing. Installation and setup of the software was provided by graduate students in a telecommunications class.

At the beginning of the 1994 fall semester, a Media Proficiency questionnaire was completed by each intern, clinical teacher, and methods faculty. Participants indicated their level of skill in various applications of technology. The data from these questionnaires was analyzed and used in the development of the inservice workshops and assignments for the interns.

Staff Development: Educating the Drivers

During the Spring 1994 semester, the interns began implementation of the technology plan. Their schedule began with three weeks in their schools in the morning and a special section of the required technology course during the afternoon. Their professor, working with the MCTP director, incorporated activities and assignments to be integrated into their student teaching experience.

A key feature was the use of electronic mail to send and receive assignments. Also, one group assignment provided an opportunity to explore a telecomputing service, educational or commercial, and develop a plan for its use in classroom. Interns were also encouraged to participate electronically with student teachers at two other teacher education institutions through MicroNet, an electronic service of Western Carolina University. Through these communications, interns were able to discuss actual classroom situations with other student teachers, to compare experiences and to utilize problem solving skills.

At the beginning of the 1994-95 year, the telecomputing component was integrated into methods courses. Interns and clinical teachers received IDs to access the mainframe computer at the university. This computer is accessed with a direct connection in the methods classroom and by telephone line from the schools. Training began with the fundamentals of telecomputing and the menu options that are available on the university's computer.

Objectives

The objectives for the staff development initiative were the same for preservice teachers, inservice teachers, and university methods faculty members.

1. To become familiar with relevant telecomputing concepts and terminology as well as the functions of system components.
2. To investigate formal and informal sources of information using telecomputing.
3. To develop a plan to integrate the use of telecomputing into the curriculum.
4. To address the North Carolina Computer Skills telecommunication competencies for grades K-8.
5. To become reflective about the process involved in using telecomputing.

Initial telecomputing training for the clinical teachers and methods faculty began in September 1994 with a hands-on workshop sponsored by Academic Computing. Participants were taught to send and read e-mail, to develop a nickname file, and to subscribe to an educational LISTSERV. In the schools, technology support was provided by Educational Technology faculty and a graduate student intern in the Instructional Technology-Computers program. In subsequent sessions for the 1994-95 school year, clinical teachers were introduced to the educational services available locally (FrEdMail, Learning Link, MicroNet, EastNet) as well as through the Internet.

This academic year, inservice training for the Leadership Team and clinical teachers as well as telecomputing training for the interns, is held in the schools on a monthly basis. This limits the group to 6-10 learners at each site. Electronic mentoring for these groups is accomplished through e-mail messages sent to each participant at least once a week. Whenever the technology professor identifies an electronic discussion message of interest to elementary school teachers, she forwards these messages to the entire group. Topics of these messages range from teachers looking for a classroom to pair with for telecomputing projects to discussions about parent-teacher relationships and the location of teaching resources on the Internet.

Telecomputing Activities

E-mail. The benefits of e-mail (one to one) communications have become quickly evident to all. During the spring of 1993, announcements were posted during the technology class; however, with the introduction of telecomputing during the 1994 fall term of the second year, communication opportunities have been expanded. Methods classes meet only twice a week. At least once a week, university faculty write messages to each intern. These messages address classroom assignments, announcements of events and opportunities on campus, and begin to formulate scenarios for discussion. Clinical teachers report weekly on the progress of the interns and their own progress in using telecomputing. Interns communicate with each other, especially those who were in different schools. Additionally, they are given assignments from their technology faculty.

Discussion Groups. Once participants are comfortable with one to one communications, they are encouraged to utilize a local discussion group that provides a forum for all student teachers at the university. Here, university professors leave scenarios of classroom situations and encourage discussion and role playing by the interns. Some discussions are open to participation by the clinical teachers. The communication highway will allow ECU student teachers to join discussions with student teachers in other teacher education programs using MicroNet. interns in MCTPs at the University of North Carolina at Chapel Hill as well as those at Appalachian State University will participate in discussions.

Each intern has been required to subscribe to one LISTSERV on an educational related topic. Computers in teaching (CTI-L), elementary education (ELED-L), the international e-mail classroom connection (IECC), KIDSNET, middle school education (MIDDLE-L), and science in the elementary schools (T321-L) were popular discussion groups. Interns record the variety of topics being discussed and their reflections on the discourse that develops. They are encouraged to participate in the discussions. With the university computer being used, it is also easy to forward a copy of the message to the methods faculty or others with an Internet address.

Internet Tools As participants gain experience, they will be introduced to tools including gopher and World Wide Web. Activities include specific directions to locate a resource on a gopher server as well as questions to challenge navigation skills. The new School of Education service, EastNet, requires Mosaic graphical software and is being accessed as schools upgrade their equipment.

Mentoring and Networking after Graduation

After graduation, students lose their accounts on the university computer; however, local and state services will continue to be available, providing an Internet address and access to the university faculty. To keep in touch with the graduates of the program, a discussion group will be formed for first and second year teachers. This will provide support during the induction period as well as identify situations which can be used by the methods faculty.

Evaluation

As an ongoing activity in the MCTP, interns submit reflective journals each week. In September, interns were asked to observe the use of technology within the school and to describe their perception of the integration of technology into teaching. At the end of the year, interns will be asked again to make a similar observation to see if there has been any change in actual use of technology as well as any change in the perceptions of the interns.

The Media Proficiency questionnaire asks for a self-evaluation as to the level of proficiency in using a variety of technologies. Each group, clinical interns, clinical teachers, and university methods faculty, completed this assessment at the beginning of the fall semester, 1994. They will again assess their own level of proficiency in the spring semester, 1995. This data will be evaluated to determine the change in proficiency during the year.

Other data will be obtained from observations by the researchers. During group gatherings, data will be collected on the concerns, reactions, and reflections of the participants. Observations, as a part of the student teaching experience, will include a record of classroom activities that integrate the use of technology. Journal entries of the clinical teachers will be analyzed and interviews will be conducted.

Conclusion

The impact of technology in our lives today is reinforced through news reports and daily encounters with computerized businesses, banking, and government agencies. Students in elementary schools today, will soon be working in a society that demands the use of technology. The Model Clinical Teaching Program seeks to create a model to prepare methods faculty, preservice and inservice teachers to integrate technology in the classroom, both at the university as well as in the elementary grades.

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Developing an Electronic Infrastructure to Support Site-Based Teacher Education

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Now in its second year, the Houston Consortium of Urban Professional Development and Technology Schools Project is continuing its development of a telecommunications infrastructure for its members. Funded by a grant from the Texas Education Agency, the Consortium is made up faculty members, teachers, staff, and students representing four Colleges of Education, 16 public schools, and local educational service agencies from the Houston area. The goal of the Consortium is to develop and promote an innovative teacher education program that includes site-based instruction, multi-cultural awareness, and a rich infusion of educational technologies for teaching interns and in-service teachers.

Telecomputing Goals

We looked at a variety of telecomputing options for our teachers, students, and faculty members with several goals in mind. These included:

- Telecomputing resources must include such tools as E-mail, newsgroups, gopher, and the World-Wide Web
- Even novice network users must be able to quickly learn to master telecomputing tools
- Telecomputing access must be available from any location, university, K-12 school, and home
- The telecomputing infrastructure must be compatible with the Macintosh computers that the Consortium is providing

With these goals in mind, we decided to offer SLIP connectivity. SLIP (Serial Line Internet Protocol) is one way that computers that are not directly connected to the Internet, can exchange information in a more user-friendly way over existing dial-up telephone lines and modems. Through this type of connection known as "Dial-Up IP (Internet Protocol)," users can easily access Graphical-User Interface (GUI) software programs to exchange not only ASCII text files, but also the many graphic image files, sound resources, QuickTime movie clips, and application files that are available on the Internet. This includes such items as Microsoft Word documents, HyperCard Stacks, and PageMaker desktop publishing documents, to name just a few. By simply using the mouse to click on icons, Consortium members can establish connections with thousands of computers around the world and transfer multimedia materials to their desktop computers.

To take advantage of the SLIP connectivity, Consortium members are receiving copies of the software and are also being trained to use the following graphical-user-interface applications for the Macintosh:

- Eudora - a GUI e-mail program
- NewsWatcher - a GUI news reader
- TurboGopher - a GUI gopher program
- Fetch - a GUI software application for easy file transfer protocol (ftp)
- Netscape - a GUI world-wide hypertext browsing program

With these software programs, users are able to easily find, retrieve, and share a wide variety of text and multimedia resources from computers in their classrooms and from home. These programs are powerful, easy-to-learn, take advantage of the Macintosh operating system, and are freely distributable. Consortium participants also receive copies of utility software programs which allow the display of graphic image files and playback of sound and movie clips. Two other pieces of proprietary software, MacTCP and MacSLIP, are required to use the suite of GUI applications and these are being provided to participants by the grant project.

During the last decade, the evolution of local area networks (LANs) and powerful desktop computers brought with it the push to bring Internet connectivity to university campuses. In the last few years, it has become possible to interconnect a vast new population of desktop computers which are able to share large amounts of data over a network. Another benefit also emerged – the ability to couple the powerful graphical user interface (GUI) of a computer workstation with direct access to the Internet and its resources. Out of this fusion has grown a new crop of GUI Internet applications that have fueled much of the intense interest in the Internet that exists in the educational community today – Mosaic, Gopher, Eudora, etc.

The name "client/server architecture" has been given to this group of client applications running on low-cost desktop computers that can communicate through a network with more powerful and expensive servers to obtain a wide range of services. These services can include printing, file sharing, database access, computation, e-mail, image retrieval, etc., with new kinds of services being invented every day. Client applications are thus freed to concentrate on providing graphically-rich user interfaces to their users.

Networking Hardware

We designed a dial-up facility to take advantage of the power of client/server architecture using a device known as a "terminal server." This device has a network interface on one side and 20 serial ports on the other. The terminal server provides a simple, dedicated method to provide SLIP by acting as an agent between the Consortium members' Macintosh computers and the Internet-connected server which is housed at the University of Houston's College of Education. For our project, we obtained a Xyplex terminal server at a cost of approximately $3,000.

We also wanted to make certain that only authorized Consortium members had access to the SLIP connectivity. With dial-up IP, many of the Internet's resources are available to all comers and without some form of authentication many "freeloaders" try to connect and gain access to the Internet. Because of this, we created individual SLIP accounts and passwords and included Kerberos authentication software that checks each time a client computer attempts to establish a SLIP connection. Before a user is permitted to initiate an online session, he or she is prompted to provide a user name and password which are verified before proceeding.

The database of our user accounts and passwords must be stored on some type of server and we chose a Sun Microsystems Sparc Classic workstation. This is a medium-sized UNIX workstation with several gigabytes of storage capacity. The cost for this type of server is typically in the $3000 to $5000 range.

Telephone Lines and Modems

Phone lines are needed to receive incoming calls to a dial-up facility and we obtained a block of 12 lines with contiguous phone numbers so that the caller is connected to any free line by dialing a known, fixed number. The advantage to this configuration is that there is a single phone number our users can call to establish the SLIP connection. We also added an additional line outside of the block for testing modems and placing voice calls.

Phone lines and communication charges are the largest recurring costs associated with our dial-up facility. Typically, these costs range from about $18 to $25 per month per line. The number of users that can be supported per line depends on the projected needs of the users. As with any group there are always a few enthusiasts — the type who have installed a second phone line at home so that they can go online 24 hours per day. In such cases, each incoming line will support only a single user. Our experience has been, however, that users connect for typically for less than 20 minutes at a time. We estimate that with this type of usage pattern, our current set of 12 lines can easily handle several hundred users without substantial delays in getting connected.

For a server such as ours, which can support up to 20 phone lines, low-cost consumer grade modems provide acceptable performance and reliability for around $100 to $150 per modem. When deciding upon low-cost modems, we wanted to make sure that the modems supported minimum standards such as V.32bis, V.42 and V.42bis. Most 14.4 Kilobyte modems now support all of these standards and a new crop of 28.8 Kb modems have now hit the market. The rationale for using inexpensive modems was that SLIP connectivity is fairly simple once all of the parameters are configured and in place and these modems should perform reliably. Additionally, with low-cost modems, we can afford to replace defective units if they fail.

SLIP Software

On the Macintosh, all dial-up IP access requires the use of MacTCP, Apple's TCP/IP software. The most recent versions of it, 2.0.4 and greater, are not available free of charge but MacTCP can be obtained by purchasing System 7.5, in which it is included or it can be purchased from Apple. MacTCP is also bundled in a number of Internet books including Adam Engst's Internet Starter Kit which also contains descriptions of MAcintosh GUI Internet tools (about $30).

In addition, we needed to provide SLIP system extension software to complete the set-up. Available free of charge is InterCon's InterSLIP v1.0.1 which can be found at many sites on the Internet. Because it is free, it offers no support, less than stellar performance, and some compatibility problems. We could not get it to work reliably with our Xyplex SLIP server, for instance, although it seemed to be reliable with other terminal servers.

Available as commercial SLIP extensions are Hyde Park's MacSLIP and VersaTerm's VersaSLIP. Both offer support, a user manual, performance optimization, and fewer compatibility problems, but at a price – $50 for MacSLIP and even more for VersaSLIP.

The Installation Procedure

Under normal circumstances, the installation and set-up of SLIP on the Mac is quite lengthy. MacTCP, the SLIP extension, and one or more Internet applications (Eudora, Telnet, Fetch, TurboGopher, Mosaic, etc.) must be correctly installed. Each installation requires placing files in the proper directories on the hard drive and supplying specific configuration information for each application or system extension. The order of the steps must be followed and the computer must be restarted after certain steps.

To make things easier on the user, we designed an automated installation procedure for setting up the SLIP connectivity software — a procedure that takes most of the tedium and guesswork out of the set-up process. This process begins by launching an installer program provided on a diskette (Figure 1).

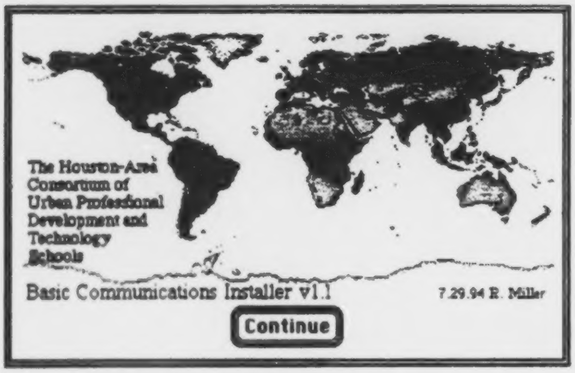
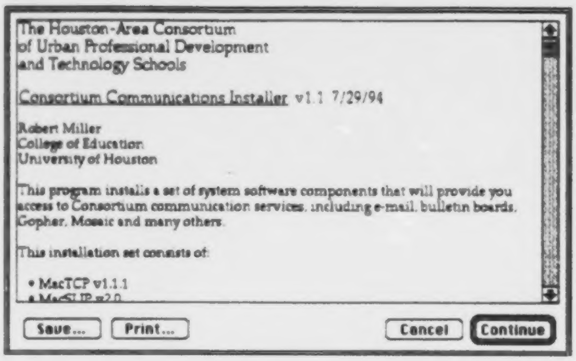

The Houston-Area Consortium of Urban Professional Development and Technology Schools
Basic Communications Installer v1.1
7.29.94 R. Miller
Continue

Figure 1. The Communications Installer Screen

The installer provides some general information on the connectivity software that is to be installed on the user's computer and presents the necessary legal terms and conditions (MacTCP and MacSLIP are licensed commercial software). The program proceeds to install the system extensions and the TurboGopher application when the user presses the Continue button (See Figure 2).

When the installer program finishes, it directs the user to complete the SLIP set-up by following the directions provided in the "readme" file installed along with the software. All that is usually needed to complete the set-up is to open the MacSLIP control panel (Figure 3), open the "variables" sub-panel (Figure 4) and enter the user's account information. If the phone number must be modified, for example to dial "9" for an outside line or turn off "call waiting", this can be done at the same time.



The Houston-Area Consortium
of Urban Professional Development
and Technology Schools

Consortium Communications Installer v1.1 7/29/94

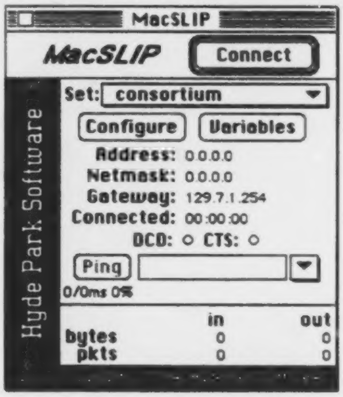
Robert Miller
College of Education
University of Houston

This program installs a set of system software components that will provide you access to Consortium communication services, including e-mail, bulletin boards, Gopher, Mosaic and many others.

This installation set consists of:

- MacTCP v1.1.1
- MacSLIP v2.0

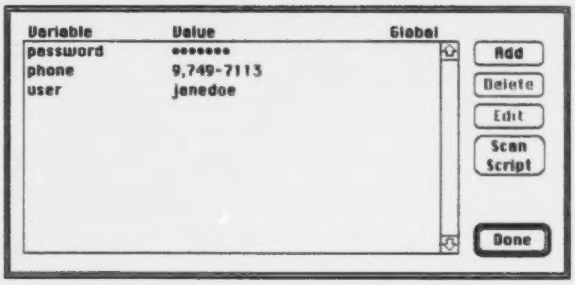
Figure 2. Communications Installer Screen



Set: consortium
Address: 0.0.0.0
Netmask: 0.0.0.0
Gateway: 129.7.1.254
Connected: 00:00:00
DCD: ○ CTS: ○
0/0ms 0%

	in	out
bytes	0	0
pkts	0	0

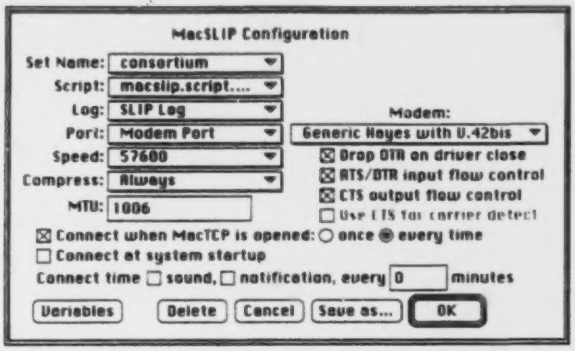
Figure 3. The MacSLIP Control Panel



Variable	Value	Global
password	•••••••	
phone	9,749-7113	
user	janedoe	

Figure 4. The MacSLIP Variables Subpanel

Figure 5 illustrates the MacSLIP configuration subpanel. During the installation process, all of this information is filled in automatically. Our users typically do not need to make changes to this information. The most common situation that requires changes to this sub-panel is a non-standard modem. Should the user have a modem other than the ones provided by the grant project (Hayes-compatible, 14.4 Kb error-correcting), changes may be needed to accommodate its characteristics. Internal modems for PowerBooks seem to be particularly "finicky" in this regard.


MacSLIP Configuration

Set Name: consortium
Script: macslip.script....
Log: SLIP Log
Port: Modem Port
Speed: 57600
Compress: Always
MTU: 1006
Modem: Generic Hayes with U.42bis
☒ Drop DTR on driver close
☒ RTS/DTR input flow control
☒ CTS output flow control
☐ Use CTS for carrier detect
☒ Connect when MacTCP is opened: ○ once ● every time
☐ Connect at system startup
Connect time ☐ sound, ☐ notification, every 0 minutes

Figure 5. The MacSLIP Configuration Subpanel

Once the user information is entered, SLIP is ready to use. The TurboGopher application is launched and a connection is made to our Gopher site, the Consortium Gopher (gopher: ftp.coe.uh.edu). There, the installation process is continued by retrieving additional Internet applications of interest to our user community (See Figure 6). In the software archives, users will find installers for the latest versions of Eudora, TurboGopher, NewsWatcher, Fetch, etc. Also the utilities needed to decode, play and view multimedia material can be retrieved. These installers are available on diskette as well for faster installation during workshops and other site visits.

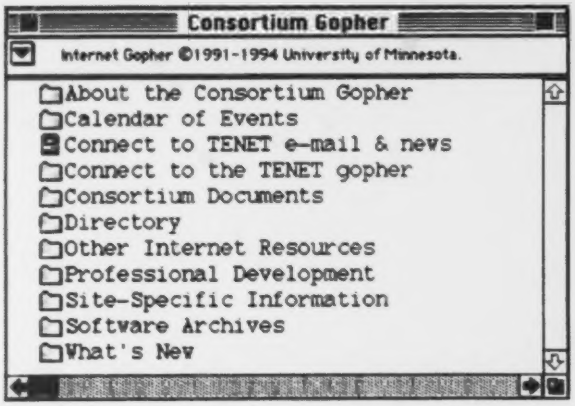

Consortium Gopher
Internet Gopher ©1991-1994 University of Minnesota.
About the Consortium Gopher
Calendar of Events
Connect to TENET e-mail & news
Connect to the TENET gopher
Consortium Documents
Directory
Other Internet Resources
Professional Development
Site-Specific Information
Software Archives
What's New

Figure 6. Main Menu of the Consortium Gopher

The "Electronic Filing Cabinet"

As part of our mission to establish a telecommunications infrastructure, we created a Consortium gopher site and stocked it with a variety of text-based documents and binary resources. Our goal was to establish an "electronic filing cabinet" to contain all of the schedules, forms, manuals, lessons, and other documents associated with our project. We selected the "gopher" mechanism over FTP or World-Wide Web/Mosaic, to act as our information server for several reasons.

A Gopher server can store and transmit both textual and binary information. This means that in addition to documents, a gopher site can provide for the storage of software and multimedia information — i.e., sounds, pictures, and multimedia presentations. It is important to us that we be able to store Consortium software and formatted (binary) documents on the server so that they are easily accessible at the many field sites. For others wishing to establish their own "electronic filing cabinet," server software is available so that gopher sites can be easily established on an ordinary Macintosh that has a permanent Internet connection. This can be a great advantage over setting up a server on a Unix workstation or other mid-range computer, particularly if you don't have access to one or do not have experience working with these types of computers.

Third, we found that gopher access was more widely available to the education community in our region of the country than was Mosaic. Gopher is quite "friendly" to the remote user regardless of whether they are accessing a site using a GUI application such as TurboGopher or a text-based gopher client such as is provided on our state education network, TENET, where tens of thousands of teachers have accounts. Mosaic, on the other hand, is not widely available to educator in Texas at this time.

Keeping Track of Users

A number of steps were taken to streamline communications between members of our community for all forms of communication including e-mail, phone, fax or postal mail. SLIP user accounts are provided, free of charge, for all individuals working with the Consortium — teachers, teaching interns, district administrators, and university faculty. Using the user information collected when SLIP accounts are generated, e-mail distribution lists and an electronic membership directory of all Consortium members have been created. These two items, together with the communication server that has already been established, make it possible to communicate easily with groups and individual members in the Consortium.

Electronic mailing lists permit the online distribution of announcements and schedules of events to groups such as our supervising teachers or the general Consortium staff. The advantage of an automated mailing list is that the maintenance of the list is centralized so that the sender needs to know only the name of the list, (Consortium-Staff@pdts.uh.edu to reach the general staff, for example). The membership of the list can change at any time but it need be known only to the Consortium server, not the sender.

Conclusion

Internet access offers significant benefits in the operation of a site-based teacher education program in the areas of communication, resource gathering, and resource sharing.

A vast spectrum of information sources are emerging on the Internet at this time and the tools needed to search for these resources — Gopher, Mosaic, E-mail, USENET News — are available to anyone at little or no initial cost.

However, access to the Internet is not free of charge. Whether through direct access, now provided by a small but growing number of school districts, or through dial-up SLIP access as described, someone must pay the bill.

The cost and effort required to set up a communications facility that can support SLIP services for a large group of educators is substantial and cannot be undertaken without some background in telecommunications protocols and network administration. School districts and other educational organizations are increasingly deciding to develop their own local telecommunication infrastructures and personnel with experience in designing and administering networks are a necessary ingredient in such undertakings. We were fortunate to have an experienced networking specialist working with our Consortium project.

In cases where local expertise is unavailable, outside consultants are often able to perform much of the design and configuration steps involved in creating a telecommunication infrastructure such as the one described here. At most major colleges and universities, network consultants may be called upon for advice and problem solving. Another source of help can be found reading USENET discussion groups. The USENET forums (e.g., comp.sys.dcom) are particularly helpful to those who are working on their own. They give the opportunity to pose questions and listen to the experiences of others who have dealt or are dealing with the same challenges elsewhere.

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Professional Development and the Internet: Experiences of Common Knowledge: Pittsburgh

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A variety of federal, state and local stakeholders are making K-12 wide area networking (WAN) an imperative. GOALS 2000 specifically links increased educational standards and schools' access to the Internet. The National Information Infrastructure (NII), which is funded through National Science Foundation (NSF), has an educational component (Newman, 1993). Federal agencies encourage K-12 Internet connectivity through a number of incentives (e.g., NSF, Hunter, 1992). A number of states and school districts are developing technology plans including wide-area networking, and parents as well as educators are demanding student access to up-to-date resources.

Common Knowledge: Pittsburgh (CK:P) is a project funded by the NSF to conduct research on the potential of the Internet to enhance K-12 education. CK:P is a partnership of the Pittsburgh Public Schools (PPS; providing project educational leadership), the University of Pittsburgh (project management and assessment) and the Pittsburgh Supercomputing Center (technical expertise). In this paper we report on the experiences of CK:P during the project's first two years (January 1993 - December 1994), focusing on professional development issues. As difficult as it is to find money to update technology in the schools, it is even more difficult to find resources to support training of educators so that they can use technology most effectively (David, 1994). If wide area networking initiatives are to succeed, teachers must be prepared to use the resources offered by these initiatives (CoSN-FARnet, 1994). A recent survey of K-12 technology use (Sheingold & Hadley, 1990) found that it can take 5 to 7 years for educators to become comfortable enough with computer technology to use that technology routinely. This "lag time" limits attempts at educational reform. In addition, many educators remain convinced that telecommunications is just another "fad" that will soon pass (Hodas, 1993).

Our focus in this paper is on veteran educators who will grapple with telecommunications issues over the next few years. We will discuss two related issues:

- How does one involve the majority of educators in wide area networking when only a few pioneers seem to recognize the educational potential of telecommunications?
- How does one prepare educators to integrate WAN into the curriculum when most lack telecommunication skills?

Getting the Educators Interested: Leveraging Change

CK:P is the brainchild of Robert Carlitz, a physics professor at the University of Pittsburgh, who became interested in the Internet as a K-12 resource and in 1989 arranged with the University of Pittsburgh to provide guest Internet accounts for local area educators. Through continuing interaction with these pioneers, curriculum ideas were developed that eventually became the heart of the first grant proposal to the NSF. By the time funding began in January, 1993, approximately 200 western Pennsylvania educators had access to the Internet. Some of these educators formed the core of CK:P in its first two years (Carlitz & Zinga, 1994).

Once the first school year of Common Knowledge was under way, CK:P staff decided on a competitive process to expand interest into other schools. With the approval and support of the school district a Request for Proposals (RFP) was announced in October, 1993 (Wertheimer, 1994). A competitive process was used (1) to stimulate interest in WAN, and (2) to develop a sense of ownership and empowerment among the teachers. During that semester workshops were offered at the CK:P beta site in a local elementary school so that educators interested in writing a proposal, but who had little or no experience with the Internet, could get an idea of how the Internet could be used. Several hundred educators, including a number of administrative and support staff from the school district central offices, attended Internet workshops, usually after work hours. Ultimately, 35 proposals were received, mostly from schools but several from community organizations. Using a review process that involved representatives of major constituent groups (teachers, administrators and parents from the school district, and several CK:P Principal Investigators (PIs) and project directors), seven schools were chosen to be second year sites. The interest generated by the RFP was both surprising and reassuring; many sites that did not receive funding proceeded on their own, making do with whatever equipment they had or could acquire through parent-teacher organizations and business partners. When possible, CK:P staff provided support in terms of advice and site visits to help set up equipment and software. In addition, a number of schools that had not submitted proposals began contacting the CK:P office for information. CK:P continued to provide guest accounts on the project's server to district educators, with dial-up access through local university modem pools. The education staff offered workshops on everything from basic e-mail to Serial Line Internet Protocol (SLIP) (which allows people to have faster access at home), which did much to encourage Internet access.

A final category of interest development was peer training. Network team leaders and librarians at first year schools acted informally as peer trainers and resource people (finding school projects via newsgroups and mailing lists) for colleagues, even opening up their homes for demonstrations of software and hardware. Team leaders at two schools offered mini-workshops during the first semester, 1994, using different models. In one elementary school the team leader offered workshops three Fridays per month during morning planning sessions. This team leader also set up local mailing lists, so that teachers in disparate classrooms using the same curriculum project could interact with each other via e-mail. In one of the high schools the team leader offered one-on-one sessions to interested teachers and staff. For this model the team leader had to make what arrangements she could, whether that was in the library, in a classroom, or in the computer lab; during lunch, a preparation period, or before or after school. The head librarians at both high schools also provided Internet training informally during work hours, by answering questions and showing people how to navigate the Internet and find resources. These activities represented educators' "in-kind" contributions because much of the preparation and resource exploration was done outside of work hours.

CK:P Formal Training Activities

During the first two years of CK:P two sets of educators were trained on Internet navigation. Thirty-one educators representing two elementary and two high schools were involved during the 1993-1994 school year, receiving initial Internet training during the summer, 1993. Ninety-eight educators representing four elementary, one middle, and two high schools were involved during the 1994-1995 school year, receiving their training during the spring, 1994. (CK:P educational and technical support of all 11 sites continued throughout the 1994-1995 school year.) In terms of Hiltz and Turoff's (1993) "phases of user development", most of the educators involved in the first two years of CK:P were in the initial "uncertainty" phase, characterized by hesitancy and anxiety toward the technology. A few participants were in the "insight" phase, characterized by a basic understanding of the technology and a willingness to explore. (These tended to be the team leaders and the librarians.) To better understand who these educators were, Table 1 describes the sample based on surveys conducted during the initial training workshops.

Table 1
Educators and Others Involved in CK:P, Jan. 1993-Dec. 1994

	First Year Sites	Second Year Sites
N	31	98
Female participants	58%	86%
Elementary	55%	74%
Middle	0	15%
High	45%	11%
No previous WAN experience	9%	52%
Some WAN experience	36%	42%
Extensive WAN experience	55%	5%

Note. Educators included teachers, librarians, other PPS professional staff (e.g., community liaison), aides and principals (5/7 principals attended some or all of the second year workshops). Head librarians were members of each school's network team. The category "Others" included community people and parents who were involved in CK:P as resource people. The overwhelming majority of participants were teachers. For first year participants the question tapping previous WAN experience was: "How often have you used e-mail?" For second year participants the question was: "How often do you log into your account in a typical week?"

Training activities over this two year period, although varied, reflected a core "empowerment" model. That model is consistent with a grassroots project which CK:P is, in large part, and is also consistent with site-based management, a recent movement in the Pittsburgh Public Schools. In essence, this is a constructivist approach which asserts that students and teachers learn best through hands-on activities that provide opportunities to construct one's own knowledge base. To illustrate this we will describe the training program developed by CK:P education project staff.

Two education project staff members were hired prior to the summer of 1993; a third professional and a full-time secretary were added by the end of the summer. Most training activities took place at a PPS elementary school, where an area had been designated as the "beta site" for staff development, resource exploration, outreach and the like. In addition to computers for the four staff members, the site eventually offered six PCs and four MACs for training and resource exploration. For the summer 1993 workshop, equipment had not yet been purchased and computers had to be borrowed from a participating school.

First year teams attended a basic skills workshop June 30-July 2, 1993 (Workshop 1; 13 hours of instruction), and an advanced skills workshop August 26-27, 1993 (Workshop 2; 10 hours of instruction). They were paid for these workshop days. The instructional method combined lectures, demonstrations, and hands-on skill building. The instructors would present a topic using an overhead projector and then participants would practice the skill. Pair learning was used for two reasons. First, the limited number of computers made it impractical for individuals to work on their own. Second, the instructors felt that the experience would be less daunting for new users if they were able to work with an experienced partner. The instructors also prepared a packet of information sheets, mostly screen dumps of directories and help screens. In addition, participants interfaced with the Internet via easy-to-use menus.

Workshop participants were taught basic e-mail including subscribing to mailing lists and accessing newsgroups; they were shown educationally-relevant databases (e.g., PENpages, NASA Spacelink) and how to do online searches. To aid their skills development and exploration, participants were encouraged to think in terms of curriculum projects. Over the summer, participants (who were able to borrow school computers to use at home) were expected to continue their exploration of the Internet. Education project staff, although not paid over the summer (nor were the participants), continued to correspond via e-mail and when needed, visited participants' homes to help with software or hardware problems.

Participants completed pre- and post-surveys developed by the CK:P assessment staff. (Survey return rates were on the order of 90%.) One question at the end of Workshop 1 designed to assess participants' perceptions of their own skills development asked: "How long will it take you to become comfortable with the Internet?" Combining several response categories, 39% indicated that they expected to become comfortable with the Internet fairly quickly (e.g., a couple of days); 56% expected to take longer (e.g., a number of weeks); and one person responded "I don't think I will ever be really comfortable." Regarding the extent of summer usage, two sources of information were used. One was a survey that was handed out just prior to Workshop 2. Another source was login data that was collected automatically. Both sources agreed that summer at-home Internet exploration varied a great deal across participants. In the survey, we asked how often participants had used e-mail over the summer. Thirty-six percent responded "daily"; 36% "about once a week"; 12% "every couple of weeks"; and 16% "once a month or less". Login data showed that two teachers who had extensive previous WAN experience logged in over 100 times during July and August; four logged in about once per day or somewhat more frequently (45-75 logins); 15 logged in about once per week or somewhat more frequently (8-39 logins); 5 logged in less than once per week; and two people did not log in at all.

For Workshop 2, participants were introduced to client/server interfaces (e.g., H-gopher), which is what was expected to be available in the schools once networks were installed. The exploration during this workshop emphasized finding curriculum materials and developing site-based implementation plans ("action plan"). The reason for having the teams develop action plans was twofold. First, it forced the educators to think through a plan for the school year, and to get feedback from colleagues. Second, it enabled the education project staff to plan their support activities. We asked the "comfort" question again at the end of Workshop 2. Forty-three percent indicated that they were already comfortable with the Internet; 11% expected to become comfortable with the Internet fairly quickly; and 42% expected to take longer.

The training for the second year was similar in philosophy, but varied in several important details. There were insufficient funds to pay the 98 participants. Instead, the education project staff negotiated an "increment credit course". In the PPS, one 15 hour course is worth one graduate credit. Upon earning ten graduate credits, the educator's pay will increase by $200 per annum. It should be obvious that such a course represents significant "in-kind" contribution on the part of the participants. The CK:P staff attributed the large turnout and enthusiastic participation to the interest generated by the competitive process. Course scheduling also had to change to manage 98 participants with only three instructors and 16 machines. Participants could choose either six Monday evenings or three Saturdays, starting in April, 1994. For each session, participants were divided into three groups. One instructor provided background on the Internet and on CK:P using handouts, overheads and chalkboard, in a lecture format. Another instructor used an LCD display device to give practical demonstrations of navigational tools, databases, and so on. The third instructor was in charge of the lab where participants worked in pairs or small groups to gain hands-on experience with the Internet.

The 1993 summer workshop was similar. This group was given more handouts than the 1993 group, partly due to what the instructors saw as gaps in the 1993 training materials, and partly due to the instructors' own increasing Internet experience. Eventually the participants were exposed to the World Wide Web via Mosaic. They were given time to explore, to find information useful for their subjects or for professional interest. Participants completed pre- and post-surveys (pre-survey return rate: 78%; post-survey return rate: 54%). Prior to the course, 32% expected to take until fall 1994 to be comfortable with the Internet; 59% expected to take from a few hours to a month; and 9% reported that they were already comfortable. After the course the percentages we[illegible] until fall, 25%; a few hours/a month, 45%; already comfortable, 30%.

The increment credit course was followed by a workshop for the second year network teams. This was a paid workshop like the one for the first year teams. It took place during three days: the first two days after school was finished for the year and the third day during the first semester, 1994. Participants were divided into two groups, one group attending the inservice June 28 to 29, the other group attending June 30 to July 1. Because these participants had had recent training on the Internet, little additional instruction was given. Instead, team members were given time to explore and develop their curriculum projects and action plans. The third workshop day often (but not always) took place once the school had at least some of its network equipment installed. In most cases these workshops were a time to refine the action plan, taking into account staff changes since the action plans were originally written, and also taking into account changes in curriculum plans due to a variety of factors, including new resources found by teachers since the earlier workshops.

Final Thoughts

Although technical delays kept teams from implementing their plans on schedule, most teams continued to meet on a regular basis and individuals continued to explore and find resources. As the first two years of CK:P ended, outcomes of the professional development efforts included:

1. From a few guest Internet accounts in 1989 to approximately 700 accounts in 1994, Pittsburgh area educators are flocking to the Internet as both a professional development resource and as a curriculum resource.
2. A number of teachers (estimated between 100 and 200) bought home computers and modems after being introduced to the Internet, so that they could have access from home. A teachers' union purchase plan helped considerably in this regard.
3. Hundreds of educators took advantage of workshops to be introduced to the Internet or to gain advanced training, in most cases without being compensated for their time. Peer training activities increased throughout the first two years of the project.
4. Educators shared professional development and curriculum resources with each other through e-mail and several principals routinely disseminated daily bulletins via e-mail.
5. Expansion continues to take place within PPS schools. Educators are finding ways of acquiring equipment or getting access to equipment already in place, and are acquiring training however they can (mostly through colleagues or through CK:P workshops, as noted earlier).

Many educators remain adamantly opposed to K-12 WAN or, at best, indifferent. The question for school districts that want to provide access to WAN is whether and how to convince these educators of the educational value of the technology. That is a question CK:P has not yet grappled with but will confront as the activity expands throughout the district.

Author Note

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The Career Development Program and Telecommunications: Research in Progress

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The nature of public school classroom teaching, particularly in the elementary school, has been one of isolation and independent professional practice. It is the rare educator who has the time or opportunity to develop consistent professional networks for support and discussion of teaching. Teacher education programs at universities have sustained this model of teacher isolation, whether intentionally or by administrative default (Goodlad, 1990). The preservice teacher is required to pursue coursework in isolation, competing for grades with other education students. Once this hurdle is overcome the preservice student is usually placed in a classroom with one experienced teacher, also working within the isolation model, for a brief time before he/she is left to complete the required rite of passage of running a classroom alone. Depending on the university and state of certification this time alone can run from a full semester to as little as a week or two (Holmes Group, 1986).

An Innovative Teacher Education Program

The Career Development Program (CDP) at the University of New Mexico (UNM) is a unique teacher education model involving the university, Clinical Supervisors, mentor teachers, and the Albuquerque Public Schools (APS). The uniqueness of CDP comes from the strong focus on interpersonal communication, development of a cohort group, community building, and connecting theory to practice from the onset of the teacher education experience. Telecommunications recently has been added as an integral component of the process by which graduate students become professional educators.

The CDP is a post BA program in its fourth year of success. Students are selected carefully from a wide applicant pool each fall and begin the program in the spring semester of each year. Students are individuals from all fields of work and life experiences who wish to acquire teacher certification by means of a hands-on alternative process. For example, this year a museum curator, a former police sergeant, a corporate executive, an airline attendant and an outdoor guide, among others, are making the transition to teaching in elementary school classrooms.

The process is accomplished with several components. Clinical supervisors, master teachers from APS, are released from their classrooms for a three-year cycle to support students and mentor teachers in their classrooms, design methods curricula, and assist with administrative requirements related to the public school/university teacher education partnerships. This is achieved through a revenue neutral exchange model.

Mentor teachers, currently practicing master teachers, work with students over the four semester program. The first semester, the mentors team with two apprentice students who are in their classrooms every day. The mentors work extensively with the apprentice team to share their professional practice experiences. In the second semester (summer) mentors support the mathematics and literacy methods curriculum training by professors and

Clinical Supervisors. The third semester, Mentor Teachers provide support to intern pairs (former apprentices) who are now team teaching in a classroom of their own. Support is provided through response journals, seminars and biweekly visits. This continues in the fourth semester when interns are separated and have a solo teaching placement. After completion of the program, interns receive New Mexico teaching certificates. In the near future the program will integrate a Masters degree.

The results of this program have been outstanding. CDP boasts a 100% hiring rate. Students become instructional leaders and innovative change agents within a year of beginning their educational career. Principals and parents in APS will often request a teacher or intern sight unseen once they know they have been trained through CDP (Campbell, 1994).

In 1994, telecommunications was added to the program. A common complaint among all participants has been the lack of immediate response to journals and the sense of isolation once teams are separated. This feeling is especially keen in CDP because a very strong cohort group is formed in the first semester of the program.

Using available equipment, all program participants have the capability to be online through either the UNM or APS mainframe electronic mail system. For the intern group of 1994, telecommunications has been an informal expectation. Currently only half of the interns and less than one-fourth of the Mentor Teachers use this method of communication.

Purpose of Study

The purpose of this study was to determine to what effect participants rate the importance of: 1) the creation of community or cohort group; and 2) the impact telecommunications had on this process. Did the creation of community and cohort groups have an impact on the developmental process of becoming a teacher? Did having the ability to communicate or connect outside of face-to-face contact allow for creation of community? How effective was the instruction in CDP? Was instruction seen as more effective when telecommunications was part of the process? The effects on teacher isolation, program satisfaction, and group cohesiveness will be measured and analyzed

Significance of the Study

An increasing body of research in the field of human cognition is demonstrating that humans learn more effectively and at higher cognitive levels when they learn in groups, (Harasim, 1989) and that learning occurs best when focused on real problems. Other research demonstrates that group learning does not have to occur in real time but can be just as effective asynchronously, or not face-to-face (Mason & Kaye, 1993). Today's technologies also support group learning (Greenfield, 1984; Vygotsky, 1973).

In the modern world people's lives are becoming increasingly busy and full of responsibilities. Devoting lengthy periods of time at a central location is becoming less and less an option for many adult learners (Merriam & Caffarella, 1991). In addition, public funding has limitations and hard fought for education dollars must be used in ways that are more effective. If learning is effective and can occur at a distance, or not entirely at one site such as a university campus, this would justify alternative means of instruction (Mason, 1989).

Many countries in the world, and a few isolated sites in the United States, build time into the teacher's daily schedule for professional collaboration and networking (Goodlad, 1990). This study will provide research that can support these innovative models of learning and training. The research will demonstrate whether group learning will add to the effectiveness of instruction, whether technology will add to the sense of community and effectiveness of instruction, and whether a graduate education experience is impacted by either of these factors. This research will add to the body of knowledge supporting theories in a number of fields including , distance education, teacher education, group dynamics and cognitive psychology.

Population and Sample

The population being studied is preservice graduate students enrolled in the four semester teacher certification program, CDP. The population will also include inservice mentor teachers serving as adjunct faculty for the program.

The graduate students are a carefully selected group of adult learners who have chosen to make mid-career changes into the teaching profession. These 26 students come from a variety of backgrounds and are screened from a field of over 100 applicants annually. The participants are selected based on three criteria: 1) a file review which includes resume, letter of intent, letters of recommendation, experience with children or volunteer work, and variety of life experiences. The files are reviewed blind by two independent readers; 2) an observation of a morning spent with children in a public school classroom; and 3) a personal interview with a committee of five, including a CDP Clinical Supervisor, the CDP Director, a UNM College of Education professor, an APS principal, and a mentor teacher involved with the program.

The 12-14 mentor teachers also are carefully selected from APS. The application process includes a file review by three independent readers, a classroom observation of over three hours, and a personal interview with a panel similar to that used for intern applicants. Mentor teachers are selected on the basis of: 1) exemplary classroom practice; 2) professional practice based in theoretical constructs; 3) ability to articulate the theory and rationale for professional practice; 4) commitment to lifelong learning and professional development; and 5) commitments to the development of new teachers. By choosing a population that includes both preservice and inservice teachers the study will have stronger generalizability to all teachers.

The study will use stratified random sampling to select 20 participants from the group of 40 for the formal telecommunications training. Each group, control and treatment, will include 13 graduate students and 7 mentor teachers. The treatment group will be randomly selected to insure unbiased selection. While the groups are relatively small, the number of 20 in each group will provide enough power to determine reliable significance, if found (Rosenthal & Rosnow, 1991).

Instruments

The variables of isolation, group cohesiveness, and program satisfaction will be measured using the College and University Classroom and Environment Inventory (CUCEI). This instrument has been chosen due to the authors' interest in "smaller higher education classes (e.g. seminars and tutorials)." This is precisely the format for most of the learning that occurs in CDP so the instrument is especially appropriate (Fraser & Treagust, 1985). The instrument identifies the following criteria and contains scales for each:

1. personalization
2. involvement
3. student cohesiveness
4. task orientation
5. innovation
6. individualization
7. satisfaction

Seven items on the instrument correspond to each of the seven scales, for a total of 49 questions. While the authors note that a few of the items overlap somewhat the distinction is enough to retain the seven separate scales. This study will look at subscale and total scores.

This is a Likert scale instrument with four choices per question: Strongly Agree, Agree, Disagree, and Strongly Disagree. The instrument is scored 1,2,4, and 5 respectively for items which are underlined. All other items are scored in reverse. An omitted response is scored 3. This instrument appears to be valid and reliable as a whole and within each subscale. Internal consistency appears to be especially strong when class scores are used rather than individual scores.

In addition to this instrument five additional questions will be administered. This addition will consist of questions specifically relating to telecommunications and concern comfort level with technology, amount of use, type of use (e-mail, conferencing, research, other), persons connected with, and ease of acquiring equipment. These responses will also be scored on a Likert scale. Instruments measuring group cohesiveness are being reviewed at this time.

Procedures

Prior to the first semester of the 1995 CDP cycle, the treatment and control groups of the study will be identified. A first administration of the CUCEI will be given to both groups in the first month of the program. In the third week of the program, the formal telecommunications training will begin for the treatment group in a computer laboratory within APS. The CUCEI will be administered again at the beginning of the third semester and at the completion of the program. The training will be once a week for one to three hours depending on the topic being addressed. Materials for this training have been developed by the author and others as part of previous doctoral projects and coursework. This training involved helping professors and graduate students in a variety of fields to connect online and function in a telecommunications'environment. The training will teach these telecommunications skills:

1. synchronous talk or phone connections
2. electronic mail
3. uploading and downloading files
4. discussing and completing academic assignments on line
5. computer mediated conferencing
6. sending and receiving reflective response journals using electronic mail
7. connecting with other classrooms
8. academic searches on the Internet

Beyond the training during the first semester of CDP the students will not have a specific time requirement to be online. In the first semester assignments will be required to be conducted online. These may include article discussions, sharing of classroom experiences, database searchers on the gopher, or jointly authored papers. Once the first semester of training is completed the study will look at how much or often participants continue with the medium independently.

Conclusion

This research will be conducted during the 1995-96 cycle of CDP. Final data will be analyzed in the fall of 1995 and published in 1996. It is hoped that significant results will encourage teacher education programs to consider innovative instructional models and implement technology as part of professional development.

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Creating a "Learning Culture" in the Electronic Graduate Seminar

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Distance education is a growing phenomenon. Today, distance education is used as a vehicle for learning by a variety of students, in a multitude of subject areas. Formats for distance delivery are equally as diverse, ranging from traditional print-based correspondence to electronic online multimedia presentations. Central to distance education is the physical separation of learner from instructor. In a number of distance education scenarios, such as delivery of instruction via audio teleconference, audiographic conference, and video conference, students meet as a class at a prescribed time. However, in many instances of distance education delivery there may be a separation of time, as well. In these cases students may be faced with a totally asynchronous learning environment — one which poses some challenges to both instructor and students.

At Athabasca University, Alberta's distance education University, two graduate programs, the Master of Business Administration (MBA) and the Master of Distance Education (MDE), are being delivered at a distance using computer-mediated communication as the primary delivery mode. Although the MBA requires instructor and students to come together for a short period of time, the majority of students in the MDE will likely not have a single face-to-face meeting with the instructor or other class members. The MDE is a graduate program designed to meet the needs of an expanding group of people who either through choice or circumstance want to acquire a full program of study, asynchronously at a distance. This program appeals to a large number of individuals provincially, nationally, and internationally who find assembling their program of studies through conventional classroom delivery simply not feasible nor viable.

Recognizing that interaction between instructors and students, and students and students, is important, Athabasca University has designed its graduate programs to utilize information technology. This ensures that students participate in a learning environment in which they will have opportunities for quality interaction necessary for developing the skills of analysis, synthesis, and problem solving. The University is emphasizing the electronic seminar as a primary mode of instruction in both core and optional graduate courses.

This paper provides an examination of the "learning culture" created within a distance delivered, student-centered, graduate seminar. We discuss the "electronic personality" and the emerging learner characteristics that influence the group dynamic. Also, the role of seminar leadership is addressed through identifying learning characteristics needed to subsequently moderate the seminar. Our purpose in looking at these elements will be to assist others, both learners and instructors, in making the transition from conventional seminar to electronic format, particularly at the graduate level, where discourse is integral to knowledge-making.

Creating a Learning Culture

Successful seminars depend on student contribution and the free exchange of ideas. This dynamic interchange is sometimes difficult to achieve. It depends on the skills and abilities of the seminar leader and the social dynamic established within the group. Any teacher will tell you that every class has its distinct group personality, in a sense, its own seminar style or "learning culture." In practical terms this means establishing how course content will be guided by the procedures, regulations, and expectations set by the instructor and negotiated by the students.

In face-to-face delivery, the learning culture of the group can be quickly assessed. After a few face-to-face meetings with the students, the instructor begins to identify certain characteristics of individual students that combine to create a certain group dynamic. In distance education seminars conducted asynchronously, using computer-mediated communications (CMC), some unique challenges are posed in identifying seminar culture. For the most part, interpretation of learner preferences and predispositions arise, not from reading visual clues or listening to the tone of the voice, but solely from what can be gathered and understood from written text, in this case CMC transcripts. An asynchronous environment makes it difficult for learners to assess the seminar culture and get a "handle" on the personalities of their classmates and the instructor, since they have only text to "read." Our contention is, however, that dissimilar as electronic and conventional face-to-face seminars appear to be, they are more alike than different.

Student/Instructor Introductions

Getting to know the instructor and the other student participants is the initial step in creating the seminar culture. As the cliché goes, "first impressions are often lasting impressions." Participants, including the instructor, begin early on to assess the abilities and characteristics of other members in the group. Introductions may take the form of posting biographies or they may be more voluntary and spontaneous. Either way, participants will test the waters of their learning environment. As in a conventional seminar, electronic seminar students will divulge personal information in differing degrees and at different rates. Some are immediately an "open book," others are more reluctant and prefer to analyze the situation. The point is that although the introduction process can be planned by the instructor, it is the student who controls the flow of the information. Therefore, from the beginning, all participants begin to establish and reveal their "electronic personalities" setting the tone for the seminar and thus creating the learning culture — the way of doing things in the seminar.

Learning Preferences

In monitoring interactions in both conventional and electronic seminars, we have found an analysis and application of learning preferences useful to assess the nature of student interactions in the group (Howard & Howard, 1994). A brief review of learning preferences is worthwhile at this point.

While there exist several instruments and inventories to identify personality types, learner characteristics and preferences (Myers, 1962; Butler, 1986; Dunn & Dunn, 1978; Gregorc, 1982; Kolb, 1976), this discussion draws from Gregorc's (1982) categorization of learning preferences. It goes further in utilizing Butler's (1986) application of learning preferences to curriculum development and to methods of instruction.

Gregorc's concept of learning style is based on dualities of ordering (sequentially or randomly) and perceiving information (abstractly or concretely). He identified four styles or categories of learning preferences or mediation ability channels: concrete sequential (CS), abstract sequential (AS), abstract random (AR) and concrete random (CR). Although learners usually demonstrate dominance in one category, they exhibit some characteristics in all four categories.

A brief description of each learning style category (Butler, 1986) follows, including a description of the kind of interactions students of each style seem to prefer. We have found these categorizations of seminar participants useful in assisting us to identify the dominant learning culture of the seminar group and in preparing a "moderator style" that acknowledges individual learning preferences, at the same time discouraging dominance of one group over another.

Concrete Sequential (CS). Participants tend to be practical, organized, thorough and structured. They learn best in orderly environments that have logical, consistent directions.

The Nature of CS Interactions. CS participants are concise and tend to focus on content. They want to be sure of directions, procedures and how they are being assessed. CS seminar members expect a structured and patterned format throughout the seminar. They constantly check for validation from peers and from the moderator, and often bracket comments within the text as a way of seeking feedback from the moderator or other students. CS participants readily assume organizing functions, such as volunteering to organize and moderate the "chat line" as a way of removing superfluous conversation from main line interactions. CS participants often share additional sources of literature to support their points, and are more forthcoming with practical applications than theoretical perspectives.

Abstract Sequential (AS). Participants tend to be conceptual, convergent, analytical and evaluative. They prefer to work independently and may find creative, cooperative activities stressful. They may be reluctant to relinquish authority and control to the group.

The Nature of AS Interactions. AS participants tend to frequent the conversation strategically, offering comments where and when they may have the most impact. They express themselves dispassionately and analytically and readily offer judgments supported through logical argument. They tend to seek validation from the seminar leader or outside authority by way of references to pertinent sources. AS participants are often well read and familiar with current literature on topics of discussion. They use the seminar as a forum for debate, and will revisit a previous debate or issue having found yet another relevant source.

Abstract Random (AR). AR participants tend to be emotionally intuitive, interpretive, empathetic, imaginative and flexible. They enjoy creative and artistic activities. ASs prefer collaborative work and give meaning to ideas in a personal way.

The Nature of AR Interactions. AR participants are very responsive to the group. Their relationships with online peers tend to guide their interactions. For example, they are very cognizant of wasting peoples time, often asking for permission or apologizing for personal ignorance. They say things like "excuse me" or "pardon me for not understanding." ARs deal with the emotional side of responses and offer emotive validations like, "I know how you feel!" They attempt to personalize content and offer explanations through re-telling meaningful and personal experiences. ARs are empathetic with people's struggles in the seminar, particularly those relating to technology. They tend to assume a counseling role, offer advice and guidance. These people often bring a sense of humor to the forum. They are concerned with how their messages are being received and understood and thus often embellish and qualify their comments.

Concrete Random (CR). CR participants tend to be original, experimental, inventive, option-oriented and divergent risk-takers. They prefer independent experimentation. Authority and limited options may pose problems for these learners.

The Nature of CR Interactions. CR participants tend to take direct questions and explore them in their own way. They are not afraid to go off topic or explore the topic from diverse perspectives. They may react bluntly to others' comments. CR's can often be very passionate about ideas, feeling free to offer editorial positions. They will frequently offer a creative point of view and are quick to pose "what if" kinds of questions. Like CS's, CR's often bring closure to a conversation by searching for practical application of the ideas being discussed.

It must be kept in mind that learning preferences are just that, preferences. When labeling a participant or the larger seminar group there is a danger of not allowing for or encouraging multiple preferences to manifest themselves. In general, students usually demonstrate a dominance in one category and it is this dominance which creates the "feel" of the seminar. By understanding this culture, the leader can exercise some control in shaping that culture.

Seminar Leadership

Seminar leadership is primarily the responsibility of the moderator or instructor. The instructor is also a participant who exhibits a certain electronic personality. We have found that the seminar leader, whether in an electronic or face-to-face seminar, has an opportunity to introduce balance into the seminar by influencing the nature of student interactions.

Rather than following a prescribed recipe for CMC interaction within an electronic seminar, we would suggest that the seminar leader develop an awareness of learning preferences, including his or her own. A seminar leader who understands the dynamic range individual learning preferences bring to the seminar are more able to recognize the nature of imbalanced interactions and thus implement strategies to encourage and balance discussions, or as the term moderator implies, to moderate the seminar. The most successful technique we have employed to stimulate interaction, as a way of moderating, is to appeal to learning preferences by strategically addressing individuals within the seminar according to which learning preference they appear to exhibit. We would like to offer these suggestions as a way to encourage student participation.

Suggestions to Encourage Participation

Concrete Sequential participants are often self-starters and information gatherers and are eager to participate, however they will become easily frustrated by things which impede their participation, such as technological difficulties. They may be encouraged by strategies such as:

- Making the technology as transparent as possible
- Giving clear and precise directions for using the technology
- Explaining expectations and assessment procedures
- Requesting varied sources of literature support
- Asking for examples from practical experiences

Abstract Sequential participants are stimulated by theoretical discussion and debate. The medium through which they communicate may not be as important as the nature of the conversation. They may be encouraged by strategies such as:

- Posing questions requiring theoretical analysis
- Setting a premise to be challenged
- Requesting sources of authoritative support
- Asking for a position statement

Abstract Random participants require the least amount of encouragement to begin and sustain interaction. They may be encouraged by strategies such as:

- Providing peer and mentor support mechanisms (e.g. chat line, help desk)
- Setting few constraints on frequencies of interaction
- Requesting biographical information
- Asking for personal experience
- Establishing a non-judgmental climate for interaction

Concrete Random participants tend to resist mandatory participation. Text may not be their preferred mode of communication. They may be encouraged by strategies such as:

- Providing open-ended questions
- Requesting practical applications of the ideas being discussed
- Asking for creative solutions to problems
- Judging quality of input over quantity of input
- Inviting input into organization of the seminar itself

Although a number of the above suggestions will encourage interaction from all learning preference groups, where dominance or a lack of balance in the seminar is noticed by the moderator, the moderator can emphasize certain suggestions according to preference.

Conclusion

Often one's assessment of a "good" class is simply a sense of satisfaction with group dynamics. The learning culture then is determined by the emerging dominance or natural balance derived from the combination of personality characteristics of the individuals in the seminar. We have found that it does not take long to begin to identify students' learning preferences whether they are in a conventional or electronic seminar. As the frequency of graduate online seminars is sure to increase, attention to the learning cultures developed within those seminars should receive serious attention. Therefore, we recommend that electronic seminar leaders develop the flexibility and patience to accommodate varieties of learning preferences for optimal student interaction.

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The *Electronic Emissary:* Design and Initial Trials

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During the last two years, the Internet-based *Electronic Emissary Project* has been helping teachers locate other Internet account holders who are subject matter experts (SMEs) in different disciplines, for the purpose of setting up curriculum-based, electronic exchanges among experts, students, and teachers. Interpersonal connections such as these are among the most powerful and promising for use in K-12 education, because they can assist teachers and students in forming and maintaining cross-disciplinary, inter-institutional working relationships. The Electronic Emissary "matches" teachers and students with professional partners elsewhere in the world, helping them to explore new ways of experiencing collaborative learning in computer-mediated contexts.

The project's initial concept, providing an e-mail link between the K-12 classroom and subject matter experts, was brought to the University of Texas at Austin by Judi Harris, the project's director. The evolution of the Electronic Emissary began when the Texas Center for Educational Technology (TCET) funded the first semester of "matches," and made available access to their UNIX-based workstation for system development and maintenance, which are provided by Greg Jones. Since the initial semester of the project, TCET has continued to provide both hardware access and support personnel to enable the Electronic Emissary to continue to grow. In 1994, additional support for online facilitation was made available by the CIRCLE project at the University of Texas at Austin. To date, the Electronic Emissary has established and supported 117 matches during three semesters.

This paper will provide an overview of the design and functions of the Electronic Emissary, then discuss preliminary results from one of several research efforts connected with the project.

Session 1 - Spring 1993

The planning for the spring session of 1993 began in October of 1992 with the design of a basic e-mail exchange system and the creation of the Subject Matter Expert Database. Our first shock came several weeks later, when a message regarding the Electronic Emissary project containing a call for Subject Matter Expert (SME) applications was created. The message was posted on 20 discipline-specific Internet lists, and within three hours, more than 30 messages asking for more information and application materials had arrived. This number later grew to almost 800 messages within a week. More than 300 SME information forms were added to the Spring 1993 database as a result of this initial contact with potential SMEs. These documents comprised our core database, of which many entries are still active, two years later.

The SME application asked for the following information:

1. Full name
2. Internet address
3. Work street address, City, State, Zip
4. Work phone number
5. Institution for which SME works
6. Brief description (1 line) of SME's current work

7. How many times each week the SME can send and receive e-mail
8. Up to five areas of expertise, explained in layperson's language
9. One-paragraph explanations of each area of expertise
10. Past experience with children ages 5 - 18
11. Other information to consider when reading the application

The provision of this information allowed the project's coordinators to reach the SME if e-mail contact was lost. More importantly, having this information on file provided eventual database users with topic searching capabilities, in-depth information about SMEs' areas of expertise, and a general sense of each SME's experience with and attitudes toward precollege students.

Reader Program

While SME applications were being collected electronically, the design and implementation of the e-mail exchange system, later named *READER*, took place. READER collects copies of all e-mail messages exchanged among participants, forwards these messages to addressees, and generates descriptive statistics on various aspects of the messages, such as length. Figure 1 visually displays the functions of the READER program.

Since the Emissary Project was implemented on a UNIX workstation, many UNIX capabilities were capitalized upon. When the system receives incoming e-mail, it is directed to the appropriate match account, which is named for the topic of the exchange (e.g., civilrights@tcet.unt.edu). The READER for each match executes four times each hour, looking for new mail. If new mail is available, READER saves a copy of the new message(s) to a master log for the account, then decides to whom to forward the message, as determined by the characters in the FROM line in the message's header. In this manner, the e-mail is passed along to the other participant in the matched team, saved for later analysis, and used to generate descriptive statistics. The READER also maintains some level of security by forwarding only messages from authorized accounts.

During the second semester of the project, the ability to send mail to an online facilitator for the matched team was added. If any participant places SYSOP at the start of the subject line in a new message's header, then the message is routed only to the facilitator. Also, if the facilitator sends a message from his/her account to the team's address, the message is mailed to both participants.

The READER program simplifies the exchange of e-mail by allowing all participants on a particular team to send e-mail to a common address, named for the general topic being discussed. Using this addressing convention, the SME could assume an online persona if s/he wished. An example might be a SME impersonating George Washington to help students explore the American Revolution. To date, no team has used this communications structure, but several different ways of organizing exchanges have been collaboratively created and refined.

Session 1 Begins

In February, 1993, matches for the first semester were made. Team discussed the following topics: archeology, astronomy, biology, biotechnics, black holes, blues, business, civil rights, computers, daycare, documentary-making, the Earth, Elizabethan England, genetics, geology, geometry, graphics, harmony, literature, media, medicine, Middle Ages, navigation, New Age, oceangraphy, physics, plants, reincarnation, water, and wave phenomena. Several important facts became apparent as the project progressed.

The call for teacher participation in early 1993 and again a year later yielded a much smaller response than did the SME call. Nineteen classrooms were matched with SMEs in January of 1993, the 19th being a gifted and talented class, which required a different match for each participating student. This resulted in 35 total matches. Some SME requests could not be fulfilled because the specified content area was not represented in the database. One such example was the need for Texas state history expertise. In these instances, teachers usually selected other areas for online exploration.

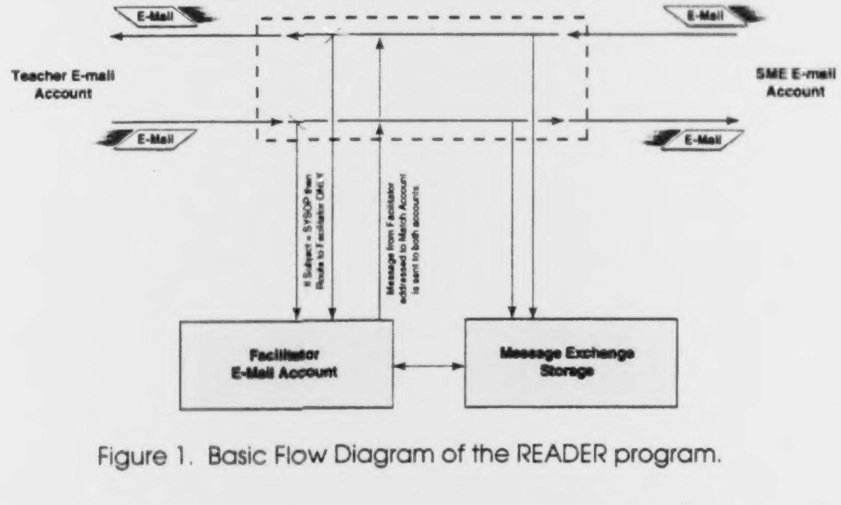

Figure 1. Basic Flow Diagram of the READER program.

This first set of matches were arranged by hand. This proved to be a time-consuming task. In addition, the process of trying to match classrooms to SMEs turned out to be more difficult than expected. Several of the matches were mistakenly made. For example, one classroom had requested a match with a SME on dinosaurs. One of the SMEs had a Ph.D. in paleontology. A great match - right ? Perhaps. Two weeks into the exchange, the SME informed us that he would not be able to answer the 10-year-olds' questions. Why? This SME was an *invertebrate* paleontologist. Dinosaurs had backbones. After this experience, it became clear that classroom teachers needed to be able to browse through the database and choose their own matches. This idea later materialized as the Electronic Emissary Exchange program, tested in the spring of 1994.

Several matches were made involving classrooms in which teachers had either recently acquired an e-mail account or were sharing accounts with others. This eventually proved to be problematic. New users often experienced technical difficulties that kept them from maintaining regular contact. The teachers who shared accounts had their share of problems, ranging from other users accidentally deleting their messages to someone changing the account password without notice. These difficulties inspired us to require later participants to have their own Internet accounts and be comfortable using them. These decisions seemed to ease later team exchanges.

During the third week of the first project semester, the TCET system crashed. It took several days to get the system back in operation, but the loss in communications and subsequent loss of confidence in the system seemed to hurt the newest users the most. Communications in 5 of the 19 teams ended during this week. In March and April, message exchange rates slowed considerably for several of the teams, The cause became apparent after communications resumed. Spring vacation schedules conflicted for members of these teams, causing for several partnerships two weeks or more of no communication.

These challenges made it clear that steps had to be taken to assist and ensure continuity of communications once matches had been arranged. Quite simply, the two researchers needed more help. 35 accounts were too many for them to support while coordinating the technical and administrative aspects of the project. The answer was to provide an online facilitator to each team. During the next two project sessions, a facilitator was provided for each group of 10-20 matches. Since the Emissary program generates a daily report that is automatically sent to each staff member, all can now efficiently monitor online activity, taking immediate action if difficulties arise.

As Judi's mentor, Glen Bull, has been known to say, "Anything worth doing is worth doing poorly." The first session of the Emissary did have its problems that could only be uncovered by piloting the project. Although the above examples highlight the problems, the ten most active groups during this session created very rich and meaningful dialogs with their SMEs. What was learned by experiencing the difficulties outlined above was how to successfully support a larger proportion of matches through long-term, successful communications. Having these problems occur during the first session helped to increase the overall effectiveness of later recursions of the Emissary system.

Session 2 - Spring 1994

The second Emissary session began in February of 1994 with 57 matches. Topics for these exchanges included: 20th century issues, geometry, Africa, Arthurian legends, computers, Greek history, photography, physics, revolution, Supreme Court, women, WWII, AIDS, animals, astronomy, behavior, blue crabs, chaos, clouds, "compugate," cosmology, desktop publihing, energy, folktales, freedom, genetics, geometry, immigration, jazz; learning, song lyrics, magnetism, ecological mathematics, pollution, Pythagoras, rainforests, reading, sharks, stars, subatomic particles, toxicology, volcanoes, weather, whales, and world events.

The primary differences between this session and its predecessor were the addition of the Electronic Emissary Exchange program, which automated the process of SME entry and matchmaking, and the online facilitation of all teams' exchanges, albeit to greater or lesser extents. Overall, message exchange tripled. The less frequently facilitated groups did not experience as many failures as did participants during the spring 1993 session. This can be partially attributed to a more stable READER program and participants' higher levels of telecomputing experience. It should be noted, however, that most second-session participants were not highly skilled Internet users.

Electronic Emissary Exchange

Figure 2 shows how the Emissary system now functions. Code from the same script is used for both teacher and SME interfaces to the database, but different options are displayed to different users, according to the passwords that they use to enter the system.

The SME interface allows new SMEs to offer their services by completing an online information form. After they have completed this form, a copy is mailed back to their e-mail address, and the original is placed in a file for later review and possible approval. The Emissary coordinator checks over the application to make sure that it is complete and that the SME does indeed have expertise in the areas listed. If necessary, the SME is contacted by telephone or the application is returned with requests for more information. In this way, the credibility of all SMEs in the database is probable. Once the application has been fully reviewed and checked, it is added to the database available to teachers online.

Teachers using the system are given the choice to either search the SME database or submit a match request, which should be done in the order stated. The query algorithm employed is a simple one-word search pattern. This simpler mechanism seems to provide sufficient capability, since teachers have searched for topics like "math," "dinosaurs," and "computers." When a search is complete, all SME applications containing the keyword(s) specified are displayed. The displayed information does not contain the SME's telephone number, street address, or e-mail address.

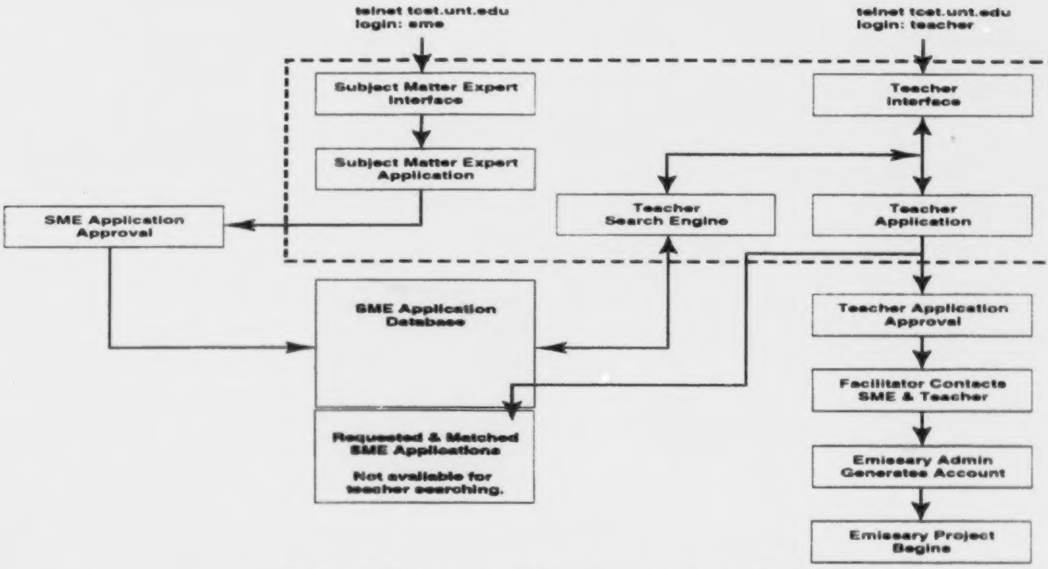
telnet tcet.unt.edu
login: sme
telnet tcet.unt.edu
login: teacher
Subject Matter Expert Interface
Teacher Interface
Subject Matter Expert Application
SME Application Approval
Teacher Search Engine
Teacher Application
SME Application Database
Teacher Application Approval
Facilitator Contacts SME & Teacher
Requested & Matched SME Applications
Not available for teacher searching.
Emissary Admin Generates Account
Emissary Project Begins

Figure 2: Overview of Electronic Emissary System

This prevents SMEs from being bombarded with unsolicited requests for communication. Teachers typically spend 20 minutes to an hour looking over SME application search results. They can read through applications located with keyword searches online and/or send copies to their e-mail addresses for later review.

We have been asked why a full list of SME applications is not available via a Gopher or similar browsing tool. We are consciously encouraging teachers using the Emissary to have selected several possible exchange topics *before* searching the database. In this way, we feel that Emissary work might be better integrated into existing K-12 curricula, rather than being completed solely in the context of a "telecommunications project."

Once the teacher has selected one SME that s/he would like to request for an online exchange, the request is filed by completing a teacher application form, which solicits the following information:

1. Full name:
2. Internet address:
3. Work street address, City, State, Zip
4. Work phone number
5. School name
6. Grade level(s) for requested match
7. Number of times per week that e-mail can be received and sent
8. SME application number being requested
9. Description of planned online project
10. Special requests or requirements
11. Other information to consider

When the teacher submits an application online, the SME application number selected is immediately pulled from the database and placed in a chosen database. In this way, multiple, simultaneous requests for the same SME are prevented. (After the SME finishes communicating with the teacher and students, their information form is moved back into the active database.) The teacher is sent a copy of their completed request form by electronic mail. The original request, with complete SME information attached, is posted to for approval by the Emissary's director.

If the match seems workable and the teacher has provided all necessary information, the application is passed to an online facilitator. The facilitator then contacts the SME whom the teacher has requested. If the SME agrees to communicate with the teacher and his/her students, the teacher is then informed of the successful match. The facilitator then requests that an electronic address be created for the match. A staff member (usually the system developer) then runs another tool generated for the Emissary project that creates the appropriate account with requisite programs and files. The facilitator is then notified that the account has been generated, and begins sending information to the new participants to help them to structure their exchange. This process has been completed in one day, but typically takes less than a week.

Use of the Emissary Exchange program and the services of online facilitators have reduced the time and effort required to maintain the project while helping to establish a higher level of satisfaction among online participants.

Session 3 - Fall 1994

The third project session began in September 1994. This was the first time that the matches had been arranged during a fall semester. As of this writing, most of the 25 matches are bringing communications to closure, covering: blue crabs, America, ecology, weather, oceans, bacteria, astronomy, evolutionary origins, AIDS, the environment,

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women, writing, mathematics, Japan, the Middle East, deserts, numbers, knights, science, computers, Irish culture, and the United Kingdom.

Although 40 matches were made available to a distribution list of approximately 75 educators who had requested to be notified when matches could be arranged, the number of requests is smaller. Coordinators of other online projects (such as Riel and Wee's "Passport to Knowledge") have reported similar (50% fewer) registration requests during fall semesters for classrooms in the northern hemisphere. Yet, overall messaging activity for matches made this semester has been high. Electronic traffic patterns seem to imply that facilitators are necessary to begin and sustain communications between SMEs and K-12 classrooms. Although several groups require no facilitation, most appear to be assisted when facilitators communicate at least once weekly.

Current Research

With participants' permission, Emissary programs maintain copies and descriptive statistics on all e-mail exchanges among participants. Analysis of the data collected from the Spring 1993 session has been completed.

Data analysis was conducted in two stages. The first stage focused on a qualitative review of the messages obtained during the project in order to determine the function and message flow of each note. Message Flow indicates direction of electronic exchange, such as: Subject Matter Expert to Teacher, Subject Matter Expert to Students, Subject Matter Expert to Teacher and Students, Teacher to Subject Matter Expert, Students to Subject Matter Expert, and Teacher and Students to Subject Matter Expert.

After message flow was specified, the content of the message was analyzed according to purpose, or function. Three general functional categories were first determined: reporting information, requesting information, or other. A message could contain information labelled as one or all three categories. More specific functional categories emerged as coding continued. These included the following subclassifications in both reporting and requesting categories: general information, personal information, procedure, content, idea/opinion/emotion, resources, feedback, and directions. The "other" category was comprised of the following subclassifications of message function: salutation, planning, thanking, complaining, and apology. Additional analysis examined message size, flow, and function over time. While coding messages, we met to compare function and flow categories assigned to message samples, improving interscorer agreement. By the end of the coding process, interrater reliability had reached 83%. This analysis yielded some very interesting trends in message exchange. A detailed report on this qualitative analysis will be presented at the AERA conference in April 1995.

320 messages were exchanged among the members of 10 groups (all class - SME exchanges, rather than individual student - SME mentoring) selected for study during the spring of 1993. Reporting of information was present in 90% of the messages, other functions were present in 79% of the messages, and requesting of information was present in 49%. 91% of the messages handled by the system were sent among members of 10 of the 18 class-based groups. The remaining 8 teams did not complete their exchanges for a variety of reasons.

Individual message size ranged between 20 words and 3,106 words, with a mean of 532.16 words and a standard deviation of 585.05 words. SMEs sent the largest messages overall.

Figure 3 shows a basic plot of message activity over time during the 15-week session. Note that the week of March 1st, 1993 had zero exchanges. This was when the server failed.

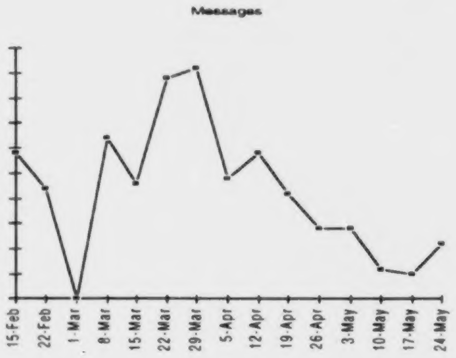

Figure 3. Message activity from Session 1.

The aim of this phase of the research is to characterize message flow and content among team members according to patterns of communication over time and with reference to speaker and audience. The Emissary programs described above make it easy to collect data for analysis, while simplifying and streamlining project management procedures.

The Future

The Electronic Emissary project will continue, and hopefully expand, indefinitely. Since the number of volunteer SMEs and classroom participants interested in communicating via e-mail does not seem exhaustible, the number of matches supported each semester will depend upon facilitation, coordination, and system maintenance resources made available to the project.

The potential for initiating and nurturing global, cross-disciplinary, inter-institutional working relationships in many K-12 classrooms via affordable, lowest-common-denominator, computer-mediated tools makes a strong argument for continuing to develop and refine the service.

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Technology 'Nformation for Teachers

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The Florida Center for Instructional Technology (FCIT) creates, organizes, and maintains a database of lesson plans on the Florida Information Network Resource (FIRN), a state-of the-art telecommunications utility that is available at no cost to all public educators in the state of Florida. The database contains records that integrate technologies such as software packages, telecommunications, laser discs, and CD-ROM to provide classroom lessons that can help teachers incorporate technology into their instruction. This project, "Technology 'Nformation for Teachers" (TNT), began in 1992 and is funded by the Florida Department of Education.

The main goal for the TNT Lesson Plan Database is to assist educators in using technology to enhance instruction. Educators can discover how other teachers are using a particular software program in their classroom, get an idea of what software may be appropriate for a specific lesson by looking at all of the lessons in a subject area, or find out what type of telecommunications projects are happening at each grade level. The responses from Florida educators have been very positive and TNT is the most frequently used database on FIRN.

The purpose of this paper is to report the existence of the database and share the process use to create the lesson plans, provide information on the database's use and describe benefits we have observed for the end users and the developers. We invite those with access to gopher to visit the TNT Lesson Plan database at gopher.firn.edu (select "Florida Information Resource Network" then select "Access FIRN Databases").

Lesson Plan Development

Developing the lesson plans involves recruiting and training lesson plan writers, contacting vendors for software and multimedia programs, editing and formatting the lesson plans, and uploading the information to the TNT Database.

The most important step in this process is finding innovative educators who are willing to experiment with technology and integrate it into the classroom. A full time project administrator is devoted to recruiting, training, coordinating, and encouraging lesson plan writers. These educators are geographically dispersed within the state and encompass many grade and subject areas. Efforts are being made to attract educators who can create a database of lesson plans that incorporate a variety of content areas, that deal with different levels of cognitive and affective development, and that cut across special educational focuses such as ESOL, multiculturalism, and so on. Technology knowledgeable educators are recruited from graduate students at the University of South Florida, on FIRN telecommunication conferences, from Learn From A Distance students, and at workshops and conferences.

Educators interested in the TNT project receive a handbook with guidelines, and attend workshops and training sessions, whenever possible. Lesson plan writers have access to software available in FCIT's Preview Center — one of the largest software libraries in the Southeast. Lesson plan writers are encouraged to use Preview Center software in their classrooms to develop creative activities integrating the software with their curriculum. They then submit these activities to the project administrator using the TNT Lesson Plan template. FCIT staff review and edit the lesson plans, which are then formatted and uploaded to the database on FIRN.

TNT Lesson Plan Template

Each lesson plan includes detailed information about the subject, grade level, software and hardware required, and procedures for integrating the lesson and technology into the classroom. The following is a sample lesson, written by Pat Freda, a teacher at Quail Hollow Elementary.

Lesson Title. Designer Creature

Associated Lesson Titles.

Grade Level. 3, 4, 5

Subject. Language Arts

Associated Subject. Biology

Objectives. Students will create an imaginary creature based on conditions in a particular biome. He/She will write about what that animal's life would be like.

Suggested Software/Multimedia. Word Weaver

Software Description. Word Weaver is a word processor with a twist. It has specific features for big book printing, booklet printing, newspaper and newsletter printing. The user can also create a draw frame for student hand-drawn illustrations. A *cloze* feature allows teachers to type or import a text passage and remove words throughout the document. This allows teachers to create reading tests. Specific initial sounds and/or vowels may also be removed. Other options include English or Spanish menus and many other packages of lessons available from the publisher.

Software Publisher.

Humanities Software
P. O. Box 950
408 Columbia Street, Suite 222
Hood River, OR 97031
(800) 245-6737

Minimum Hardware Needs. Macintosh Plus or better with 800K of free memory, System 6 or 7, Super Drive (the program comes on a high density disk; the publisher will provide the program on regular disks on request), Hard Disk with at least 2.5 MB free space, printer.

Other Materials. Disk (to save work in progress), reference materials - encyclopedias, books on animals, etc., crayons, markers, pencils (for artwork), needle and thread, glue or stapler (to bind booklets).

Alternate Software. Word processor (MS Works, Claris Works, MacWrite, etc.)

Optional Materials.

Optional Hardware/Peripherals. Scanner (to put student artwork onto the printer page).

Suggested Setting. Single computer classroom, one student at the computer.

Time Required.

Setup Time: 30 minutes to install and become familiar with features.

Class Time: Two 30-minute periods on the computer for each student.

Prerequisite Skills.

Computer: Basic use of the Macintosh computer, typing skills (not necessary but will speed up creation of story/report).

Subject: Students should have a basic knowledge of animals and their habitats.

Vocabulary: Biome, Arctic, Tundra, Temperate Zone, Desert, etc.

Rationale for Using Technology/Software: By using the computer, students are able to produce professional looking books in which they take pride.

Special Considerations: Some students will need more time than others to complete their story. Also, plan on spending extra time teaching students how to insert a graphic frame into their document.

Procedure.

Off the Computer.

1. Students research different climactic areas of the planet (biomes).
2. After choosing an area, students decide on attributes a creature would need to survive in that area.
3. Students write a rough draft of their story of the animal (optional).

On the Computer.

1. Using an LCD panel the teacher shows the students how to use the program.
2. Show students the Page Setup option from the FILE menu. Students will pick the booklet feature.
3. Show students how to insert a frame by choosing Place Draw Frame from the EDIT menu.
4. After placing a sample frame, show students how to type their story.
5. Demonstrate the printing of a document by choosing Print from the FILE menu.
6. Show students how to save a partially finished file by selecting Save from the FILE menu.
7. Students type their story and print it out. As an alternative, you may have one or two keyboard literate students type in stories. This could eliminate extended time at the keyboard.
8. Extension: place all the finished books in the library or other public display.

Off the Computer.

1. Students take their printed pages and add a picture inside the graphic frame (if a scanner is available, students will put the picture in the frame while using the program).
2. Students bind their book by stitching the pages, gluing or stapling.
3. Students present their book to the class by reading their story about the creature they have created.
4. Have students make a table or chart of animal, biome, and student given characteristics. Then analyze and sort: e.g., Animals (mammals) in Arctic climates all have (or

should have been given) thick coats and/or much layers of, that human dreaded, fat. This could be expanded infinitely.

Evaluation Activities. Teacher can evaluate students knowledge by how well the characteristics described by the student allow their creature to survive. The teacher may also want to have the students share their books with younger students.

Using the Database

Educators can search for lesson plans by grade levels, subjects, suggested software, and several other criteria. Searches can be performed by looking for a value exclusively or inclusively, for example, searching for lessons for grade level 8 only, or searching for lessons that include grade level 8. Searches can also be performed with multiple selection criteria such as searching for grades 7 and 8. Boolean operations of AND and OR are also supported.

Once the search is complete, a list of lesson plans that match the criteria is displayed. The educator can select which lesson plans to display in a detailed format.

There are limitations to the current database software. For example, there is no support for printing or downloading; educators who want a copy of a lesson plan need to have telecommunications software that allows them to do a screen capture, or use the print screen function of their personal computers. We are currently in the process of investigating software upgrades for the FIRN database and of establishing a gopher server for the database that will allow educators greater control over the individual lesson plan records in the database. Eventually we want teachers to have complete control over retrieving, saving and printing lesson plans at their own computers.

Benefits

The benefits realized by the TNT project have been many. The lesson plan writers have the advantage of previewing software and trying it in a classroom setting prior to their school incurring the cost of the software. Through the FCIT Preview Center, they have access to the most current software on the market. We have also found that the experience of writing the lesson plans encourages the writers to increase the use of technology in the classroom and increases their computer and telecommunications skills. The authors also become part of a statewide network of educators, often doing joint projects with each others classes and providing technical and emotional support.

Educators using the TNT database benefit from the experiences of the lesson plan authors. Incorporating the lessons from the database gives variety to their teaching. The teachers can see which software and technologies work well for the authors and get ideas for the incorporation of the software into their own classroom settings. Through a group conference established on FIRN, the teachers can provide feedback on the lessons, discuss related issues, share ideas, and have an additional resource for technology support. The teachers gain confidence in using technology and are better prepared to make requests for the types of technology they need.

The schools benefit by greater use of the technology already purchased as well as insurance that any future purchases will be used. The publishers of the software also benefit by having another means in which to expose educators to their products. As you can see, the TNT project has benefited all those involved.

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An Electronic Newsletter for an IT Graduate Program: Steps and Strategies

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Bernard Robin
University of Houston

This paper describes some steps toward the implementation of an electronic newsletter in an educational setting. The strategies of selecting appropriate material for the intended audience and how electronic distribution of information can facilitate change will also be discussed.

As today's students become the workers of tomorrow they will need complex analytical skills (Hancock, 1993). Teachers also must ready themselves for the coming challenges of the Information Age and educational institutions must provide the information tools needed to meet those challenges.

Learners, both students and teachers, now and in the future have and will increasingly have a need for information. They will be called upon to recognize and find appropriate information sources and will need to know how to gain access to the data contained in those sources. The key to effective use of information is being able to evaluate the quality of information obtained and organizing it in a usable form (Doyle, 1992).

For the teacher, information and computer literacy coalesce well with resource-based learning (Hancock, 1993). The Internet (Tennant, 1992), the largest of all computer networks, can be utilized as the focus for a very information-rich resource base. A newsletter is a tool that can be used to familiarize teachers and learners with this giant resource.

The Newsletter

Traditional newsletters are relatively short, informal printed documents that are narrow in scope. They are intended to inform, in a quick and concise way, subjects and/or issues relevant to their readers. Newsletters vary widely in format and publishing schedule. Some are mostly text-based with only an occasional graphic or picture. Others are graphically-based, with most of the information disseminated through color and design. Another possibility for developing a newsletter for the Information Age, is that of the electronic newsletter.

A newsletter for an Instructional Technology (IT) audience is a logical choice for using an electronic format. The reader is called upon to practice new technology skills and to use computer tools in a more expanded manner. The IT reader further benefits if the electronic newsletter is delivered in a computer network environment. The delivery medium itself becomes a learning experience which extends the knowledge base of the reader.

A newsletter for an IT graduate program needs to be focused on technology but may also be broad enough to include associated subjects. The newsletter should include graduate educational issues as well as general education subject matter. The bulk of the newsletter should be information pertaining to instruction, computer hardware, software, networking and updates on new implementations of current technologies.

Design

Design elements for an electronic newsletter present some unique considerations. Within a network environment, a text-only newsletter may enjoy the most readership because electronic text files are deliverable across multiple computer platforms and operating systems. With the proliferation of direct Internet connections in schools and the increasing availability of SLIP (Serial Line Internet Protocol) and PPP (Point to Point Protocol) connectivity options, this text-only element of design will surely need to be reassessed in the near future. However, even as graphical-user interface network tools are becoming more popular (Robin, 1994), the majority of network users are limited to a text-only network interface.

The delivery method should also be considered when designing the text format for the newsletter. The majority of networked computer display terminals support 80 columns wide by 24 lines high. The lines should be no longer than 66 to 72 characters wide to aid in readability. Paragraphs should be no longer than eight to 12 lines long with a blank line separation from the next paragraph with no indents (Hart, 1993).

Many electronic newsletter editors use a banner type headline in order to add uniqueness to the end product. They sometimes use regular keyboard characters with imagination to simulate a picture or large type face font. Keep in mind that designs made with large amounts of spaces and tabs are often distorted during network transmission.

Information

In order to publish a newsletter one must have information to publish. If you do not already have the information then you will need to get it from a reliable source. The Internet is one such source. Most universities provide their faculty, staff, and students with affordable Internet access. Some K-12 schools have their own network access while others have service through an associated university. Since most Internet users have access to electronic mail, they also have access to the thousands of electronic mailing lists that provide copious amounts of information.

Some examples are:

NET-HAPPENINGS	InterNICs IT list majordomo@is.internic.net
EDUPAGE	EDUCOMs news update edupage@educom.edu
EDISTA	Educacion a Distancia (en Espagnol) listserv@usachvm1.bitnet

Another tool for information gathering is Usenet News. Thousands of Usenet newsgroups are available on a variety of educational and technology-related subjects. Some examples are:

news.announce.newusers
news.newusers.questions
k12.ed.tech
misc.education
sci.edu

Most network providers also provide access to Gopher, an excellent source of an enormous amount of archived electronic information. Some example Gopher sites to explore are:

gopher gopher.ed.gov	[U.S. Dept. of Education]
gopher chronicle.merit.edu	[Chronicle of Higher Edu.]
gopher gaia.sci-ed.fit.edu	[Florida Tech Edu. Gopher]
gopher informns.k12.mn.us	[Internet for Minn. Schools]
gopher goldmine.cde.ca.gov	[California Dept. of Edu.]
gopher gopher.ed.uiuc.edu	[UIUC: College of Educ]
gopher shiva.educ.kent.edu	[Deaf Education Resources]

Editing

All editing for the electronic newsletter can be done in your favorite word processor and/or text editor as long as the end product is saved and uploaded to your network as plain text. Keep in mind that the end user may be reading your newsletter on any number of computer platforms. Text file length is not usually a problem online, but if down-

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~88~   P~~~88~~~Y   ~88b      88~  d8~~~Yb P~~~88~~~Y  ~88~~~~~Y dP~~~Y
  88       88        88Yb     88  d8     Yb    88       88      dP
  88       88        88 Yb    88 d8       8b   88       88      Yb
  88       88  _____ 88  Yb   88 88       88   88       88__d    Yb__
  88       88  ----- 88   Yb  88 88       88   88       88--Y     --Yb
  88       88        88    Yb 88 Y8       8P   88       88            Yb
  88       88        88     Yb88  Yb     dP    88       88            dP
 _88_     _88_      _88_     Y88_  Yb___dP    _88_     _88_____d b___dP
~~~~~~   ~~~~~~     ~~~~~~    ~~~~   ~~~     ~~~~~~   ~~~~~~~~~~ ~~~~
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________________________________________________________________________
   -==] The E-NewsLetter of the Instructional Technology Program [==-
 -==] College of Education, University of Houston, Houston Texas USA [==-
------------------------------------------------------------------------
                           September 15, 1994
                              Vol.I, No.X
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Figure 1. Banner Headline for IT-Notes E-NewsLetter

loaded to a desktop computer, some software products will not open a file larger than 64K. Therefore, you may wish to limit the size of each electronic issue. Another reason to insure that the newsletter is of moderate length is the interest level of your readership. It may be more constructive to start with a publication that is short and have readers comment about adding more elements than to have one that is too long and loose readership due to excessive length.

The writing/editing style of the end product should be tailored to its audience. Many editors use informal verbiage intended to be warm and personable. Others choose to deliver their information in a no-nonsense, straightforward style. Keep in mind that graduate IT readers are usually busy individuals who appreciate being able to easily locate needed information.

Delivery

Delivery of the newsletter is greatly tied to your user base. A number of delivery options are available and the online capabilities of your readers should determine which options you choose. An entry level user will be able to access e-mail and subscribe to an online mailing list. This option is relatively easy for the sender to use, but not the best choice for the recipient due to bulky message headers. If you have the capability to set up a listserv, this can eliminate the bulky header problem. A moderately experienced user base will also be able to use Gopher or anonymous File Transfer Protocol (FTP) to access copies of the newsletter. Your local network administrator will be able to help you decide if these options are available to you. At our university, we have found that a combination of e-mail plus gopher access is a useful solution for distribution of the electronic newsletter. We upload the newsletter to our local gopher site then send only a short e-mail notice via a listserv program that indicates publication dates and content information for each issue plus instructions for how to log onto the gopher site.

Change

According to Nicholas (1984) there are two important ideas essential to the concept of change. These are: change is never not happening and change begets more change. Change should be an intrinsic part of the newsletter and should be responsive to the user base. When appropriate, change the content to reflect the interests of the readership. As the end users acquire more online skills then add other versions of the newsletter to reflect and augment those skills. Telecommunications networking can dramatically change teaching and learning (Eisenberg, 1992). Investigate the level of graphical support within your local network and when possible, add a graphical version of your newsletter. The Internet and networking as a whole are changing also. An electronic newsletter is one way to take advantage of those changes as they present themselves.

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The End User of Internet: Integrating Technology into the Classroom

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Research for Better Schools

The need to understand the end user in order to develop, demonstrate, and promote applications of information technology in education was identified as an important issue by the Committee on Applications and Technology of the National Information Infrastructure Task Force (1994). The exponential growth of teachers and other stakeholders in education who are becoming end users of Internet makes urgent the need to identify methods and strategies that effectively teach how to use and integrate Internet for educational purposes. Internet, recognized as a catalyst that enhances professional growth by providing network access to information and resources and by creating communities of educational leaders engaged in critical inquiry, is a valuable tool to use in efforts to reach The National Educational Goals. The need prompted two initial questions. Can educators learn to use Internet to access information on a database? Once educators learn to use Internet what would they do with the skill?

The Participants

Nine educational sites agreed to identify an Internal Change Facilitator (ICF) who would partner with an outside supporting agent, Research for Better Schools (RBS), to gain full Internet access. The ICF administrator received notice that RBS would work with the education site to explore the phenomenon of introducing Internet into an educational system. The study was supported by funds from two federal programs, the Mid-Atlantic Eisenhower Consortium for Mathematics and Science Education and the Laboratory Network Program (LNP), a collaborative of 10 regional educational laboratories.

Seven schools and two intermediate service agencies, the Montgomery County Intermediate Unit (MCIU) in Pennsylvania and the Educational Resources and Information Center (ERIC) in New Jersey, entered into a partnership with RBS to learn the use of Internet. Seven schools represented K-12 sites including urban, rural, public, and private schools, and were dispersed throughout the region served by RBS: Pennsylvania, New Jersey, Delaware, Maryland, and the District of Columbia. A technical systems director and a facilitator from RBS, the external change facilitator (ECF) were directly responsible for the training and technical assistance offered each of the nine ICFs.

Procedure

Phase 1, from April to June 1993 focused on connecting each site to Internet service from JvNCnet, a mid-level NFSnet member, to gain access to an educational database developed by RBS. The database contained four categories of information: ***research and development collections, promising practices, calendar of events***, and ***resources*** such as government agencies, professional organizations, and mathematics and science materials available for teachers. Each site was visited by the facilitator from RBS. Working directly with the ICF, skills for accessing the database were introduced. The volunteer liaison learned how to log on to Internet and look at the research and development information and resources placed on Internet by the efforts of the LNP. The ICF was supported by the ECF to take advantage of the rich resources available through the full Internet connection after exiting the database. Each ICF was encouraged to share his or her experience with anyone else at the site through a turn-key model. The facilitator from RBS remained in contact with each site through e-mail, telephone and fax. A group meeting on June 10th at RBS brought together the ICFs from the sites, other participants from the sites, and RBS staff to share their Phase 1 experiences and plan for Phase 2.

Phase 2 started on September 1st, 1993 and continued until April 1st, 1994. Information was gathered through on-line data collection, site visits to each participating educational site, e-mail, and an end-point survey collected online. Interviews with each ICF clarified how Internet was used, identified barriers and recognized links that had been established for dissemination. In November, each site was visited to identify needs, barriers and application of Internet use to systemic reform efforts at the site. Analysis of all the collected data sought to understand how each site used Internet. Factors inhibiting the dissemination of use of Internet were noted. Discussions, plans and implementation that inhibits the spread of the use of Internet was documented. A group meeting in January brought the participants together at RBS to share experiences, find resources, identify needs, and plan for the final months of connection offered to the participants. A survey was placed online and collected by March 1st, 1994, to mark the end of the study and collect the final data.

Data

Data include the invitation to participate and letter of acknowledgment, site profile, logged on-line time for each site, a documented on-site interview during phase 1 and phase 2 with each ICF, e-mail correspondence, documented discussions at whole group meetings, and a online end of study survey. Because of the variety and quantity of both quantitative and qualitative data, the triangulation method was used for evaluation.

Results and Discussion

The year long study examined, described, and analyzed how the ICF learned basic skills, found time to use Internet, and integrated and applied new skills professionally. The study also examined what role the partnership between the outside agency and the ICF played to provide professional development and educational change at the site. The success of turn-key models to disseminate the use of Internet to others at each site was analyzed.

The results of the year long study suggest that end users can learn to use and apply Internet when the following factors are addressed:

1. Access: There is a dependable, consistent, and secure connection to Internet.
2. Skill Building: End users' skills are built through practice using telecommunication tools that align professional goals, school curriculum and classroom strategies with student needs for increased learning.
3. Ongoing Support from an outside agency that is responsive. Support to users' risk taking and serves to inform and enhance systemic change.

Limitations recognized by participants concerned:

1. Equity: All participants were already in possession of computer hardware. This led to concerns about schools being unable to participate if they didn't have basic equipment.
2. Time: More time was needed for initial training of basic skills and for practice, planning and integration into classroom activities.
3. Costs: If costs were not covered initially by outside funds, participation would have been impossible.

Since the inception of this study, technology and the need to provide network access to educators have become a national and state focus. Equity and open access, difficult issues to solve, are being addressed by ongoing discussions. In each Mid-Atlantic state, aggressive network strategies to provide access to all schools are in the planning stage. Schools are looking for ways of providing network technology to their staff. Some teachers are getting accounts and becoming end users. This makes even more imperative the need to identify effective methods to teach Internet use and to integrate its power into educational systems.

Conclusions

The positive results obtained by this study indicate that in a short time, less than 5 weeks, Internet can be introduced and used at an educational site. At each site, the ICF, regardless of type of K-12 educational site, previous experience with computers, professional responsibilities, and sophistication of computer hardware (as long as it met the necessary threshold to use a communications package to access dial-in service to Internet) spent hours online learning new skills, sought information and resources, and communicated with other educators. During phase 2, the ICF, now a proactive Internet user sought ways to maintain Internet connection and influence others to grow professionally by creating onsite opportunities to learn and use the technology of Internet. Each ICF found the partnership with RBS to be a necessary factor to the success of incorporating the use of Internet at an educational site and continues to collaborate and problem solve with the outside agency. Each Internal Change Facilitator has taught others how to use Internet. Four sites engaged in long range systemic planning used this technology as a theme for professional development. The four liaisons are directly responsible for over 300 educators having hands-on experience to learn the power of Internet and are working with teachers at their sites to incorporate the technology of Internet into the classroom.

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TEAM: A Paradigm for Learning in Graduate Education with Technology

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TEAM - (Telecommunications, Education, and Multimedia) is a graduate Long Island University degree program that evolved into a powerful educational system of collaboration, interdependence, synergist envisioning, empowering, and action that builds a learning community. TEAM demands personal responsibility for learning and develops purposeful uses of information based technologies.

Our Department of Educational Technology began a master's degree program in Computers in Education in 1983 focusing on powerful uses of technology to advance teaching and learning. Students took a mix of core courses and electives culminating in a master's "action thesis" or project that was required to "make a difference" in teaching/learning in the schools.

In 1990, in addition to our regular program, we added a special weekend TEAM program: 20 students, each required to have a computer and modem at home, joined faculty mentors on Saturdays for six credit hours during the fall and spring semesters for two years and six credit hours of course work for each of two summers. At the conclusion of this time, all completed the equivalent of the same courses in our regular program but as a cohort group - building, learning, sharing together, and encouraging learning electronically to continue every day throughout the two years. Based upon the success of TEAM 1 and our evolving sense of satisfaction with the concept, we started another Saturday group (TEAM 2) in the fall of 1992.

Somewhere between the later stages of TEAM 2 and the onset of TEAM 3, we noticed significant changes in both our pedagogy and our philosophy. As faculty/mentors we approached learning in new ways. We saw ourselves and our own evolution as immersed in the evolution of TEAM. We conversed with passion and excitement about the interconnectedness of all we were doing, of dialogues that took unique forms when face-to-face and when electronic, and about building shared visions of learning communities of the future.

Simultaneously, a) our outside work with a think tank of exceptional educators focused us on learning and technology, b) our reading and rereading of key scholarly works from a broad base grounded our learning systems in thoughts with others, and c) field-based activities we were creating, leading, and nurturing moved us ever closer to an understanding of learning communities. We saw strong reasons to replace our regular program with teams, since it no longer made sense to us to offer separate courses. Teams permit us to build over time, powerfully, in threaded and integrated ways.

We began TEAM 3 in September 1993, and TEAM 4 in January 1994, both on Wednesday nights, which were our first groups to "compete" with our regular program and traditional schedules. These teams began with our sharpening conceptualization of what TEAM was. We immediately incorporated TEAM building, which consisted of knowledge sharing, various forms of dialogue, and building a vision as we read with the students seminal works that focused on structures and systems thinking in businesses and organizations and less on education and schooling.

Our dynamic conceptual frameworks, our understanding of the roots and elements of what TEAM is and what it might become, grew in spurts and leaps just prior to the onset of TEAM 3 and has deepened since. These still evolve as we continue to share our growth with our newest TEAMs - 5 and 6. Below we describe the growth of the TEAM concept along with our frameworks - the compelling vision and critical elements that exemplify our essence: 1) our building blocks of learning, mastery, interdependence, and synergy while committed to self-growth and contribution, 2) our focus on leadership, scholarship, and excellence, and 3) our metaphors of jewels and journeys.

Building Blocks

Our students realize early that opportunities for learning lie everywhere around us. They know, too, that a variety of skills may be necessary to sustain learning — wherever, whenever, and however. Our newest TEAM students begin immediately using technology tools: telecommunications software and Microsoft Word, PowerPoint, Excel, and Access. They learn e-mail the first week and then VAX Notes, our electronic bulletin board conferencing system, the second. All immerse themselves in their own and "group" learnings. Individual and small group technology contracts are written with goals for personal and professional growth. Those who have never touched a computer before usually learn basic skills with telecommunications, Word, and PowerPoint while those more experienced delve into the intricacies of Access and an exploration of the Internet. We present "learning" each week as a few students share PowerPoint mini-shows of whatever they are learning and also dialogue about it electronically between classes. Everyone learns from everyone else.

Pea and Gomez (1992) review the impact of electronic learning systems and point out that the heart of any communication is the "negotiated meaning" arrived at by all parties. When technology is involved, the barriers imposed by electronic systems (lack of eye contact, voice tones, body gestures) may have to be compensated for and those available must be enhanced. Our students, in many ways, are pioneers in using electronic learning links and will aid us in defining and refining their uses.

Gardner (1991) studies learning and learners and advocates powerful models such as contemporary children's museums and apprenticeships. Each can be active, meaningful, fully engaging, and sensitive to what Gardner calls individuals' multiple intelligences. His two models apply naturally to the types of learning systems we construct along with our students in TEAM. Exploration of technology tools (in class and at home) is like a children's museum experience - playful, interactive, valued, and fun. Learning comes along with the exploration. Apprenticeships are also at play as our students learn while working on real projects with accomplished people in and out of TEAM. Some of our students work on a community project combining telecommunications and in-person activity with 1,000 children and community members across the 100 miles of Long Island. Sometimes, they learn from experts as they contribute to the creation of a dynamic learning community. Other times, they become experts for others. While using telecommunications, video, and multimedia, they participate as both apprentices and craftspeople.

Learning is intrinsically motivating when purposeful. Our students do not learn arbitrary skills but rather help to construct their own meaning, processes, and products, all of which are valued. Students talk about engagement in learning, immersion in learning, and self-directed mastery because they are intrinsically motivated. When they falter, we as a team address strategies for next-step successes.

We value expression, communications, and self-assessment aimed at developing greater and greater clarity of vision and purpose toward becoming self-actuating lifelong learners. Students write journals every week about themselves, their goals, what they value, and how to construct learning to move them toward their dreams. Plans may be altered during the week as the learning evolves, but students must write about it, learn to express it clearly to themselves and others, and plan their own learning. And they must write about issues of learning, leadership, and technology. Tools such as PowerPoint, Word, and their electronic communications become intuitive parts of the process for building clarity of thought and power of expression.

Learning requires much more than being exposed to content. A key metaphor for our students is built around the cyclical sense of information gathering through the stages of seeking - sifting and sorting - synthesizing - sending and sharing. Technology often plays a major role in attenuating these stages by speeding them up, providing ways to handle vast amounts, and enhancing the mental modes necessary to build meaning. Finally, in an information rich society, technology helps the learner to move the synthesized entity back into the electronic neural network's information pool quickly and broadly where others may use it to enhance their own learning. It may then return to the learner in modified or new forms and be processed through the cycle again. The more developed each of these stages becomes in the learner, the more effective and efficient the process of learning becomes. Our uses of e-mail and VAX Notes conferences model this process and provide a laboratory for testing personal and group learning. Group Systems V (GSV), our powerful planning and strategy groupware tool, raises this process to an even higher level. As further development occurs in the groupware field, we expect this sense of group action on learning to become even more enhanced.

When more than one learner works, it is critical that a sense of organization be in effect. A key work in building learning organizations is Senge's The Fifth Discipline (1990). Senge sees organizations as learning communities where real learning permits us to extend our capacity to create our future (generative learning). A learning organization is one "where people are continually learning how to learn together" (p. 3).

Team Learning

We see meaningful living and learning as most often interdependently accomplished with others who are themselves pro-active, self-motivated, capable learners. People tend to see themselves as most successful and accomplished, most satisfied and fulfilled, when collectively doing something they believe in with others. Covey, Merrill, and Merrill (1994) talk about the fire within, the passion, the drive, and the thrill one feels when doing something of true importance. Building from individual skills and then to the collective experience, they see life as most profound and rich when realized with a synergy of interdependence. Senge (1990), focusing on building learning communities, emphasizes creating mental models and personal mastery. He also discusses the poignant and powerful constructs of team learning and shared vision. The magazine, *Executive Excellence* (1993-1994), examines issues related to people, organizations, impact, effectiveness, leadership, and value. Articles are varied and written by people willing to envision future scenarios and new paradigms. Covey and Senge both write for this publication. New TEAM students receive a two year subscription to *Executive Excellence* and are also required to read books such as those by Senge and Covey.

We seek excellence and high quality in every step we take although we expect bumps, walls, and bends in the road. Sometimes our detours just seem to waste time but often they are rich learning experiences. We seek to know the difference, to understand when to reach for others' help and when to explore, persevere, and learn by taking multiple paths ourselves. Sharing the learning with others and hearing about their paths and journeys offers a continual focus on "learning" itself and methods to succeed without traveling each path alone. Teams of people do not merely decide to learn, live, and act together and become instantly accomplished at it. Creative and focused systems thinking, though, can nurture, respect, and develop successes within and between teams and other learning/life systems while facilitating overlapping personal and professional growth and action.

Learning Tools While Using Them

We learn together not only to use technology tools but also how to most effectively learn to use them while using them. We combined, for example, using GSV and VAX Notes with extraordinary results as we addressed the communication of ideas and our team building. Learning to use the tools was accomplished with a combination of handouts, some instruction, lots of support, hard work, and everyone helping everyone else.

To encourage cross-group collaborations, we combined TEAMs 3 and 4 for three evening sessions in spring 1994 while students and faculty mentors addressed issues raised in Perelman's provocative book, *School's Out* (1992). Perelman calls for the end of education as we know it and its replacement with hyperlearning environments. This work, which some found frightening, some outrageous, and others exhilarating, was shared in sessions that used 1) GSV, 2) in-person conversations, and 3) VAX Notes. Each method of communication and expression offered something that the others did not.

GSV allowed all students, as equals, to input thoughts and ideas and then build electronically into a collective, yet complex, understanding of what "the group" thought about Perelman's ideas. Secondly, in-person conversations added eye contact, body language, voice, and interactions that were "alive" and could not be replaced electronically. Finally, the electronic conference on Perelman's book allowed dialogue to continue potentially 24 hours/day, every day from the time it was opened.

VAX Notes conferences link thought, dialogue, and action. They are rarely static philosophical conversations. Something frequently happens because of them. One student found a dialogue driven by Perelman himself on the Internet and immediately downloaded it and distributed it to the others. She also joined in that conversation and welcomed others to do the same as she discussed its impact upon her in VAX Notes. The conference itself is filled with portraits of our participants. Some begin shyly and then become more and more open with their thoughts and ideas. Others expound philosophies about life and learning right from the start. All become comfortable with one another. They trust they can say what they feel and that others want to listen and respond. To date, we have about 30 conferences on various topics open in TEAM.

We seem constantly reminded that the whole is greater than its parts, that independence and interdependence while collaborating on meaningful activities produce synergy and results. Activities then become the foundation for next levels of activity, synergy, and further growth. Our tools were learned quickly while the focus was on communicating ideas.

Diversity, Richness, Cohesion

We attracted a few people from business and industry as well as a good mix of knowledgeable and novice technology users into Team 3. It seemed like a good idea. At this point, it seems better than just a good idea. We have recently begun to articulate thoughts about the power of diversity within the teams and depth of our experience and actions when that diversity became powerful as we created shared visions and engaged in collective actions. In several instances it seemed that it was diversity not only in TEAM members' backgrounds, strengths, and challenges but in the complexities of their lives, in what they value and what they want to contribute and learn. When shared, something happened to others as they considered options that they perhaps never might otherwise. In addition, our course content became enriched when we saw ourselves as naturally intertwined and yet coming from varying disciplines and fields. Most of our students who teach believe in an integrated curriculum that sees areas such as art, science, and language as naturally linked in nature when viewed in a broad and rich context. TEAM members who are educators, artists, business people, and/or scientists and who come together for a purpose, build shared activities that blend naturally. Interdisciplinary, integrated, intuitively connected, a high school mathematics teacher may grow more in his/her life when collaborating with artists, musicians, scientists from local research laboratories, and varied groups

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of learners (students). Technologies may facilitate time and place shifting, ease of communication, openness of expression, and joint access to seemingly unlimited people and resources. What these people then do together grows from what they value and desire and how they choose to build collectively.

As our teams have grown in diversity and cohesion, they have been empowered by the creation of their shared visions of the future built from multiple perspectives. It is not merely learning in teams. It is learning in teams with fire and passion burning from a commitment and desire to contribute to community. With it opportunities and challenges abound for creative imagination, growth, and action.

> The power of vision is incredible! . . . Teams and organizations with a strong sense of mission significantly outperform those without the strength of vision. According to Dutch sociologist Fred Polak, a primary factor influencing the success of civilization is the "collective vision" people have of their future. Vision is the best manifestation of creative imagination and the primary motivation of human action. It's the ability to see beyond our present reality, to create, to invent what does not yet exist, to become what we not yet are. It give us capacity to live out of our imagination instead of our memory. (Covey et al, 1994, pp. 103-104)

We are beginning to consciously build these elements into our work. We seek diversity and then structure learning situations that foster conversation, growth, and action as we create and then move toward our collective and compelling visions.

Leadership, Scholarship, and Excellence

Leadership

In May and June of 1994, we held a course in leadership and learning. We brought TEAMs 3 and 4 together to study leadership techniques and the GSV tool. One of the faculty mentor/leader/instructors was the superintendent of a large school district 100 miles away and trained in skills such as GSV facilitation and cognitive coaching in addition to educational administration, leadership, and learning. That semester some students learned to use GSV and actually facilitate sessions while others learned about using the tool as they participated and considered its impact. All students studied leadership. For a second course, one group studied simulation and gaming, another television and video production, and a third, multimedia using ToolBook. All students were responsible for communicating electronically and for conceptually filling "baskets" overflowing with tales of learning and living. As it was summertime, they were to play, explore, and experience using various technologies and to write about learning, leading, and living as they thought about them while truly "re-creating." We then separated for six weeks as we continued to fill our "baskets." When we came together again in August, it was a powerful rejoining and a building for the coming year. Learning, leading, and collaborating had continued for most throughout the summer both in-person and electronically. Our semesters seem to flow one into the next and build exponentially over time. The learning, living, and leading frameworks are beginning to flow naturally into everything we do.

Since that summer, one TEAM 3 student has been engrossed in the combined study of 1) cognitive strategies, 2) GSV, 3) VAX Notes conferencing/communications, and 4) Senge's work on learning communities. Concurrently, faculty mentors are studying the growth of leadership and learning within teams as we structure and study our environments with our students. These activities are not only related but are dramatically changing with our studies as we change with what we learn.

Scholarship and Excellence as Integral to the Model

In our pre-TEAM models of teaching, we valued scholarship and excellence and interwove them into the fabric of our varied courses within our program. At this point, scholarship and excellence are being redefined as permeating all that we do and adding to the power of the thoughts and actions we engage in. The framework is structured with all students reading and responding to a core of foundational works while collaborative groups within us delve deeply into other related areas and share them. The outcome is that no work stands alone any more than any one of us stands alone within TEAM.

Gardner (1993) portrays seven contemporary creative geniuses, each of whom exemplifies one of his seven intelligences. To read about them as Gardner compares and contrasts them is different from how it might be to read about each separately. Together, they speak of creativity, innovation, the 20th century, history, and life. To read and react to them together with others in all of our team, brings multiple perspectives powerfully into active learning and dialogue.

Likewise, the impact is extraordinary of all teams reading Gardner with Pea and Gomez, Senge, Covey, Perelman, and individual selections from what seems easy and unfettered access to all information. We are thinking in new paradigms - not because we want to be innovative or different but because as we consider what we value and what we think, we are seeing different visions. Interestingly, some of the growth is coming from the natural blending of scholarship and practicalities. Seeing scholarship as separate from purpose is, perhaps, like seeing art or history as separate disciplines to be studied in school. Our learners see themselves as scholar/practitioners. We are open to the complexities and richnesses of having multiple perspectives with multiple individuals and groups that value life and learning. Products are more naturally high quality as producers are intrinsically motivated and value excellence.

Metaphors of Jewels and Journeys

We conclude with two metaphors that represent our vision.

Jewels

We seek to create jewel-like systems and challenge others to join, model, or create their own. Each TEAM becomes its own jewel - unique, sparkling, vibrant, multifaceted, and whole - exquisite in its own right. The TEAM of faculty and students may be a collective whole that includes each TEAM members' strengths and contributions in addition to the "bright lights" in each members' life - those people of significance and impact in their lives. Jewel-like because we believe there are magnificent qualities within each member and extraordinary synergy from the interconnections between them and others. We accept nothing less. Individuals open to TEAM must rise to its purpose and help to define, build, grow, learn, and create the jewel. We are not yet accomplished in this metaphor but it clearly represents our thoughts as they glimmer and glow.

Journeys

With joy, we journey alone and together. Our tools are changing in what they can do, what opportunities and challenges they provide for us. Simultaneously, we are changing in what we choose to develop and use in our tools of the future. Rather than see ourselves as technology experts or change agents using technologies, we see ourselves as voyagers who often change and are changed along our journeys. Each day may be viewed as an adventure from wherever one is to wherever one chooses to go. Learning to use technology tools when appropriate and powerful and to see oneself ever-learning is a continual life process. We seek to define the journey with its challenges and successes as opportunities for growth and action. In TEAM we choose to respect, trust, forgive, treasure the quest and the journey - the journey alone and the collective journey. We have no room for passengers; everyone works in multiple roles to make the journey successful.

Onward

Where will we go with such TEAMs? Every semester ends with an Educational Technology event where students present glimpses of their learning over the semester to us and one another in fair-like fashion. Graduating students are highlighted as they present more formally their culminating work as students in our program. That work must be built from an understanding of philosophical and pedagogical foundations and principles and a desire to "make a difference" in a learning system. Final work with us is viewed as synthesis, communication, and commencement.

Students are beginning to want their final work to be collaborative, grander, and more powerful than what they see in the world around them. We expect our newest students to learn in, perhaps, one year, what took two years for our previous students. By the second year, they - and we - should be exploring territory that we may not envision today. TEAM is not perfect. Some students drop out after a week if they sense it is not for them. A few still see their graduate education as a "tack-on" in their lives rather than integral to them. Most, though, help to redefine with us the directions we take when we are not meeting their needs. Overall, students and faculty say TEAM has changed them, freed them, empowered them, and energized them - with purpose, excitement, and a passion to contribute.

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The Rochester Area Interactive Telecommunications Network (RAITN) and its Impact on Teacher Education: A Progress Report

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College at Brockport

In September of 1994, the State University of New York College at Brockport went "online" with a state of the art interactive television studio. The studio at Brockport joins five others already in operation at various sites throughout Monroe County in Western New York State. In addition to the SUNY Brockport studio, two more studios will be added during the fall of 1994, bringing the total number of stations operating on the network to eight.

The Rochester Area Interactive Television Network (RAITN) is the result of a collaborative effort among private industry, the State University of New York, the Board of Cooperative Educational Services (BOCES), and several public school districts. The partners in the first phase of operation were: Rochester Telephone Corporation, NYSERNet (New York State Education & Research Network), Rochester Institute of Technology, Monroe #1 BOCES, Monroe #2 BOCES, Webster High School, East Rochester High School, East High School in the Rochester City School District, Olympia High School in the Greece Central School District. SUNY Brockport is the newest addition to this consortium.

RAITN gives its members the advantages of distance education with a dramatic difference — real time interaction. Each RAITN studio is equipped with two way sound and video capabilities allowing each classroom to be in contact with each other classroom on the network. Two way communication is provided over a fiber optic and copper cable network allowing the transmission of slides, video tape, computer output, overhead transparencies, and other media sources. The instructor or facilitator is located at one of the classrooms, but can see all of those participants at each of the other classrooms on the network at that time. Each studio has a camera which displays a video feed of the class. Each studio also has a second camera which allows broadcast from that classroom to all the others. Cameras are available in each classroom to show the instructor as well as the entire class. Full zoom and pan capabilities are available for each camera in each location giving the instructor access to all parts of each of the studios on the network. After a very short period of time students begin to feel that they are all part of one large virtual classroom. As the technology being used becomes familiar to students, they seem to forget that many miles separate them. The feeling most students have is that everyone is in the same room.

RAITN permits new forms of connectivity among school districts, BOCES, and colleges. RAITN allows for the delivery of courses to high schools such as Swahili and American Sign Language which could not be supported by a single school. Special programming such as workshops on multicultural diversity, SAT preparation, and AIDS awareness have been brought to each of the locations. In addition, the network has been used for interactive video conferences and "electronic field trips" where students interact with remote resources.

This semester the State University of New York College at Brockport is using RAITN to teach two undergraduate courses and two graduate teacher education courses. Baseline data has been collected on student attitudes and expectations and exit interviews will be conducted with a sampling of students from each of these courses at the end of the semester.

Some Observations Along the Way

One of the authors has experienced teaching on the RAITN network and interviewed others. Some of the preliminary feedback is quite interesting. One instructor enjoyed teaching on the network because it was "the best equipped classroom" he had ever used. Another felt that the most important thing missing was true eye contact with members of the class now dispersed to several locations. Several felt that the technology took too much of their time and that their topic or lesson was relegated to second place. Most agreed that the process of focusing student attention or cueing is very different on the network than in an individual classroom.

Teachers who have a style of teaching in which they roam throughout the room find themselves hindered by placement of desks, cables, cameras, and other equipment. Teachers who use the overhead camera, a replacement for the blackboard in this higher tech environment, tend to distance themselves from the class since what is being broadcast most of the time is not their image, but that of a sheet of paper.

All instructors interviewed have underscored the feeling that it is more exhausting to teach on the network than in a standard classroom. This is probably due to the fact that the instructor must be cognizant of many pieces of technology while attempting to deliver a class at the same time. The feeling of being "on stage" all the time also leads to this feeling of being totally drained at the end of class. These comments regarding physical exhaustion increase as the length of the classes taught becomes longer.

RAITN and Teacher Education

Of particular interest to the State University of New York College at Brockport is the potential impact of RAITN on preservice and inservice teacher education programs. During the developmental stages of RAITN, before the studio at SUNY Brockport was completed, a special series of seminars called *Conversations* was developed. This series of seminars brought special interest topics and high profile figures from politics and education to student teachers and supervising teachers area schools. *Conversations* proved to be successful and programming of this type is planned for the future.

During the fall 1994 semester two graduate level courses are being offered to inservice teachers. *EDI590.03 - Teaching Critical Thinking* is being offered at two of the RAITN sites to a total of twelve teachers and *EDI590.02 - Middle Level Education* is being offered at three sites to a total of twenty teachers. Enrollment is somewhat lower in these classes since they were added to college offerings late in the registration period. The questionnaires and surveys being used as part of this research are being administered in these two classes.

In addition to courses offered to inservice teachers, plans are being made to use the network as a vehicle for video conferences among supervising teachers and college faculty and for regular seminars for student teachers. In the spring semester of 1995 a portion of the weekly seminars for secondary student teachers will take place over the RAITN network. Two graduate level courses will be taught for inservice teachers and one course will be taught for school administrators. Most of the new, exciting, and creative ideas for the use of RAITN seem to be in the teacher education area. The spring semester of 1995 will see the majority of uses of the network focused on preservice and inservice teacher training.

Issues and Concerns

A major concern of the RAITN planning committee is that the network not be used for the delivery of traditional lecture type courses; courses that could be better taught in person or through a simple video tape. The interactive nature of RAITN implies utilization in formats which would capitalize on interaction among students and instructors. Faculty members in the Department of Education and Human Development and Educational Administration are working toward using the network to its best advantage. Seminars, panel discussions, and other interactive types of formats have so far seemed to be the most successful. The least successful formats are those which involve pure lecture or extensive use of the overhead camera as a substitute for the blackboard.

During the fall semester of 1994, one of the authors had the opportunity to observe two different courses being taught on RAITN. One was a traditional undergraduate lecture format course and the other a graduate seminar course. The difference was striking. RAITN did not seem to be the proper vehicle for the lecture course. The only advantage was a larger audience, which could have been accomplished through use of a large lecture hall. It was amazing to view three video screens showing classrooms with students simply sitting, listening and taking notes. It seems that instructors who are excellent lecturers actually loose effectiveness on the network.

The seminar course, on the other hand, used the interactive nature of the network to best advantage. The students were actively involved in discussions which transcended their location. The effect was indeed that of a virtual classroom where distance was not perceived. It seemed as though all the students were in the same location. Conversations flowed freely and students at each of the sites took responsibility for zooming in on each speaker in turn. The results were wonderful. It seems that the more students are involved at each individual site, the better the class becomes.

Attitude Questionnaires and Exit Interviews

At the end of the fall semester of 1994, the same attitude instrument which was given at the beginning of the semester will be administered again. A random selection of students from each of the graduate education classes will also be interviewed. In addition, instructors who have taught on the network will be interviewed regarding their observations.

The focus of the questionnaires will be to determine if there has been any shift in the baseline measures gained from the administration at the beginning of the semester. The exit interviews will attempt to probe in more detail individual student's feelings regarding their educational experiences on RAITN. These interviews will follow a series of guiding questions, but will be largely open ended in order to allow for as much student input as possible.

Conclusions

The RAITN studio on the campus at SUNY Brockport has been operational for less than ten weeks as of the end of November, 1994. It is apparent after only this short time period that this technology will change how we do business as teacher educators. Although we could still be considered to be at the embryonic stage, this interactive network will have a profound impact on how we deliver courses, supervise student teachers, run student teaching seminars, and communicate with the teacher education community at large.

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Planning to Receive a Teleconference on Campus

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Teleconferencing via satellite offers the opportunity for educational dialogues between interested individuals over great distances. It offers great potential in education. Individuals may see a notice of an upcoming discussion that is being offered via teleconferencing. The desire to schedule the teleconference may be present but unfamiliarity with the process may cause individuals to hesitate in initiating such an event. Actually, the process is very simple. Knowledge of the steps to take and useful questions to ask, can lead to a successful teleconference on one's campus.

Notice of Event

Notices of teleconferences appear in professional publications such as journals and newsletters. Certain teleconferences may be particularly beneficial to your students, especially when the topic addresses course content or when the individuals participating in the teleconference are authors or educators whose work your students have read or studied. Such individuals may speak at conference locations too distant for your students to attend. The teleconference offers a way to overcome that distance and expense.

Usually teleconference announcements mention the cost of receiving the broadcast and technical information related to the type of bandwidth that will be used for transmission. It is necessary to know this information before calling your media department.

If the broadcast is of educational benefit and affordable, the first question to consider is, "Does my campus offer this capability?" Contact your media department and ask if the campus is capable of receiving the satellite transmission. Mention the bandwidths referred to in the announcement.

If your campus can receive the transmission on that date, determine which specific rooms can receive the program and if they are also available on that date. Determine the seating capacity needed and determine if one site will suffice or if several such sites will need to be linked to accommodate an overflow crowd. Reserve the needed rooms. Ask if phones (or faxes) can be set up in the room(s) and make arrangements for those needs.

Cost Considerations

Teleconferences vary in cost. The fee allows you to receive the broadcast for local viewing. The sender may also provide a videotape of the proceedings or your local media department may videotape the broadcast as it takes place. The videotape may then be reused locally. Some broadcasters may allow rebroadcast over local cable channels but limitations may exist and need to be checked. If you are considering the use of multiple sites to receive the broadcast on campus, check with the sender to make sure simultaneous receipt in several different rooms (to accommodate overflow) does not incur extra charges. Some receiving institutions consider charging attendees to recapture some of the expense incurred in receiving the broadcast.

Ordering

If the rooms and your media department personnel (and satellite) are available, you will need to order the program. Usually, you can order by telephone or fax your purchase order or credit card number. The sender will then provide the details that your media department will need to locate the correct satellite and channel. Ron Akin of the Southwest Texas State media department has prepared a checklist for gathering this information . The checklist provides information about reserving the services of the Media department, room capabilities and characteristics, and phone information. The following information is requested:

- Date of Transmission
- Time of Transmission
- Satellite Name
- C or Ku Band
- Transponder Number
- Channel Number
- Test Signal Time (Start and End)
- Help Number
- User Name
- Department
- Account

A contract may be sent for the receiver to sign prior to the broadcast and coordinates for receiving the broadcast may not be released until the contract has been signed. Ask your local media department about any additional expenses involved for local expenses in downloading or phone set up.

Print Matter

The sender may provide print information or material related to the presentation topic and the discussants. If you are able to receive this in advance, you may duplicate the information for the participants at your site.

Local Panel

An interesting presentation is certain to generate comment, both before and after its occurrence. It can be useful to have a local panel to begin discussion or to react after the broadcast. Arrange for a moderator to assist the discussion. Furniture should be arranged to facilitate the discussion. Use good principles of panel design to maximize success.

Timing

If a panel is included, arrange a starting time 30 minutes before or an ending time 30 minutes after the actual program is scheduled to air. Announce this information in your publicity notices. The extra time allows you to orient the audience to procedures, introduce the local panelists, and to begin or close discussion locally.

Publicity

Provide print information that details the date, time, place, topic and panelists. Encourage public announcements, class announcements, media coverage (campus newspaper) as possible. As space may be limited, allow a means for reservations to be taken. This ensures proper planning for room space and for any paper handouts. This may help you avoid having to turn away interested parties because of lack of space.

Last Details

Provide an agenda for your local panel moderator. Include information about the local panelists. Prepare large nameplates for your local panelists to assist your moderator and audience participants. Print out the list of advance registration attendees for a sign-in sheet and to later determine attendance.

Our Event

Notice of a particularly interesting teleconference appeared in the newsletter of a professional organization. Several of our faculty were interested in receiving the teleconference but had not directly planned to receive one before. The teleconference would be beneficial to receive and additional benefits would be incurred as faculty learned how to plan such events on our local campus. There was also the potential for involving students in the planning so that they also would learn how to arrange for a teleconferencing event.

After determining funds were available and conferring with our Dean, we proceeded with planning for the event. As a primary site, we used a room within our education building that was particularly suited for receiving the program. This room had been tested on only one previous occasion. We also included an off-campus elementary school site for field-placed students and public school classroom teachers to attend.

We invited a panel of local experts to be available for discussion before and after the event. Our panel included preservice teaching students, faculty, state officials, district curriculum planners and classroom teachers. As soon as the advance print material for the conference arrived, it was made available to panel members. We printed large nameplates for the panelists for easy identification by the moderator and other panelists. Arrangements were made to reserve parking spaces for our off-campus visitors.

Fliers were circulated within our department and other related departments on campus. Announcements were made in classes and personal contacts were made to individuals that might be interested. Each announcement included a phone number for reservations.

On the day of the event, the communications department set up the fax machine in the room. The tables were arranged for our own local panel. Our moderator suggested that our panel sit in a semicircle facing the audience and made certain we had enough handouts and space for those audience members that replied. Our moderator welcomed those in attendance and introduced the panel. Audience members were provided with forms for writing questions that could be faxed to the national panel.

Drawbacks

After all this preparation our conference did not materialize as transmission did not go through and we received no picture. Apparently, this was the case at sites across the nation. We proceeded to have a discussion among those panelists and audience members that were present. Those originating the broadcast have rescheduled the teleconference for a later date. We will try again to host receipt of the program.

It was of course very disappointing not to have the conference proceed as promised. Planning had involved the cooperative efforts of many people. It was valuable to have a written contract to clarify financial responsibilities. We were glad we had not asked audience members to pay for the privilege of attending the teleconference. Returning the funds would have been an added difficulty.

Credits

Financial support in sponsoring the teleconference was provided by the Southwest Texas State University Center for Professional Development and Technology.

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Effectiveness of T1 Telecourse Delivery on Mathematics Instruction

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Since the adoption of the new Utah Core Curriculum for Mathematics, teachers in school districts across the state have had varying degrees of inservice on Core philosophy, goals and objectives, implementation strategies, and assessment. Some teachers have participated in summer workshops and periodic school district seminars, yet there has been no systematic, statewide Core introduction or implementation plan.

The new Core differs substantially from the 1986 edition (slightly revised in 1991) in several distinct ways. The 1993 version is modeled after the Curriculum and Evaluation Standards (National Council of Teachers of Mathematics, 1989). These national Standards have redefined mathematics as problem solving, reasoning, communication, and connections with explicit emphasis on instruction that ties mathematics concepts to real-world experiences (NCTM, 1989). This change from the traditional view of mathematics as decontextualized symbolic manipulation and rule acquisition provided the impetus for this study.

The explicit emphasis on relating mathematics to real-world experience or phenomenon is undoubtedly **the** element that causes classroom teachers the most concern. The emphasis on relevance in State and national Standards demands that mathematics be taught in ways that elicit the critical connections between mathematics and its applications.

Relevant instructional practices are teaching strategies that are characterized by pedagogy wherein a learner expresses an interest in pursuing study of a particular topic or concept, recognizes the practical significance of that topic, and extends subsequent conceptual understanding by reflecting upon additional applications or generating new theoretical considerations (Dorward & Trezise, 1994). The underlying premise for this instructional approach is that active, real-world experience and knowledge precedes conceptual understanding (Dewey, 1902; Piaget, 1966; Vygotsky, 1962).

In states with geographically disbursed rural populations, educators rely on distance education technology to deliver cost efficient programs. Utah's Governor, Michael Leavitt, has been very supportive of the Utah Education Network's efforts to provide educational opportunities to his constituents over the T1 telecourse system (Leavitt, 1994). The T1 system utilizes fiber optic telephone lines to transmit audio and video signals to remote sites. This system provides participants with virtually instantaneous interactive audio transmission with a slight delay and eight frames per second in video transmission.

Several studies have looked at the effectiveness of the T1 delivery system in teacher inservice (Barker, 1987; Kitchen & Kitchen, 1988; Neufeld, 1985; Slaton & Lacefield, 1991). Three of the previous studies relied exclusively on post- course evaluation measures. One study utilized a pre-, post-course questionnaire to assess changes in participants' attitudes toward interactive telecourses (Neufeld, 1985). No previous studies have used multi-method evaluation strategies to assess the degree to which the T1 delivery system is effective in increasing teacher use of relevant instructional practices.

Purpose of the Project

The purpose of this project was to provide exemplary inservice training on the Utah Core Curriculum for Mathematics to elementary and middle level teachers in rural Utah communities. This training was conducted by a team of teacher educators from four of the six teacher preparation institutions in Utah, over the Utah Education Network's T1 compressed video network. The project was designed to address the following conditions:

1. The new Utah Mathematics Core Curriculum needed to be implemented in rural settings in a meaningful way.
2. A large percentage of rural elementary and middle level teachers are poorly prepared to teach mathematics as it is defined in the state Core.
3. Newly-available technology and well-established school district/university cooperation increase the possibilities for successful inservice.

Specific project objectives included the following:

1. Increase rural teachers' understanding of the Utah Core for Mathematics and its implications for instruction.
2. Increase teacher awareness of the interrelationships between mathematics and real-world phenomenon by eliminating constraints to planning and implementation.
3. Increase implementation of exemplary elementary and middle level classroom teaching strategies and practices.

The emphasis on providing strategies for increasing relevant instructional practices in classrooms while integrating hands-on activities into an interactive telecourse format was the major challenge confronting the project team.

Evaluation Procedures

There is an adequate body of research to suggest that contextual instructional practices increase student problem solving abilities, spatial abilities, and interest (Mukhopadhyay, 1990; Pinxten, 1987; Smith, & Dunnington, 1986). Little research has been conducted which identifies elements that characterize contextual teaching approaches or explores issues related to preparing teachers to implement relevant instructional practices.

The degree to which the model improved teachers' understanding of the Utah Core Curriculum for Mathematics with relevant instructional strategies was the focus of the evaluation plan.

Evaluation of the project utilized multiple assessment measures. Mixed method research designs have been shown to be most effective in gathering information useful in more formal experimental studies (Caracelli, & Greene, 1993). Talmage and Rasher's (1981) spiral strategy of merging information from qualitative and quantitative methodologies in order to examine increasingly more complex issues served as the model for this evaluation.

Assessment procedures included a detailed description of the four program phases, content analysis of class discussions and examinations, observations of remote site activities by the site facilitators, and a pre- and post- course survey developed by the investigators and administered to participating in service teachers.

This paper reports on results from implementation of the first course which focused on Core Standards and associated instructional strategies for teachers of Kindergarten through Second Grade students. Evaluation questions addressed in this report include:

- To what degree did participation in the telecourse stimulate an increase in relevant instructional practices in participant's classrooms?
- To what degree was the project successful in integrating hands-on activities into an interactive telecourse format?

Conclusions from the Study

There were 16 teachers from two remote sites involved in the course offered during Fall Quarter, 1994. All participants were full-time teachers at the primary (grades K-2) level. The mean age of the participants was 36 and they had an average of 8.3 years of teaching experience. Only one of the 16 teachers had previous inservice training on the Math Core and no participants had previous experience with the T1 telecourse system.

Project Features

Delivery of the instruction was based on a systemic model developed by Donald R. Daugs at Utah State University for implementation of the new Utah Science Core (Daugs, 1994). Course sessions were coordinated by the principal investigators and conducted by selected teacher educators and master classroom teachers from around the state. Content and technological site facilitators were present at each remote location to provide technological assistance, coordinate hands-on activities, and distribute assignments.

The first course consisted of ten, three-hour inservice sessions. Each session involved 1 and 1/2 hours of instruction over the interactive video network and 1 and 1/2 hours of associated hands-on activities and assignments coordinated by a trained site-facilitator. Specific features of course design included:

1. Specific grade-level focus for each course.
2. Trained site-facilitators at each location to oversee hands-on activities during each session.
3. Strong curriculum emphasis on instructional activities that relate mathematics to real-world experience, using technology to enhance instruction, and including meaningful alternative assessment opportunities and strategies.

The project was designed to operate in four phases: preliminary field testing, site facilitator training, implementation, and follow-up.

Phase One: Preliminary Field Test of Electronic Delivery System

Most aspects of the offering had been tested over the past three years in graduate programs of the university partners. The T1 delivery system had been implemented very successfully with a similar elementary science education program.

The field test component of this program involved four remote sites. The field test consisted of delivering one sample lesson in early September 1994 involving each of the three studio sites. The field test provided project developers with feedback for modifications needed prior to extended presentations.

Phase Two: Site Facilitator Training

Content site facilitators were selected by the principal investigators in cooperation with the participating school districts. Each site also had a trained technical facilitator provided by the network. Selections of the content facilitators were based on mathematics content and instructional expertise, assignment, or experience that corresponded with the grade-level focus of each course.

Each facilitator attended a two-day training seminar at Utah State University in advance of each quarter. The training seminars familiarized each facilitator with the T1 system and provided an opportunity for participants to revise curriculum and receive instruction on the dissemination and use of lesson activities and manipulatives.

Phase Three: Statewide Implementation

The first course, delivered over the T1 system during Fall Quarter 1994, focused on Core Curriculum implementation strategies appropriate for kindergarten through second grade. The second course, delivered during Winter Quarter 1995, focused on implementation strategies appropriate for third through fifth grade. The third course, delivered during Spring Quarter 1995, focused on implementation strategies appropriate for sixth through eighth grade. Each session was video taped for use in the follow-up phase.

Previous electronic delivery projects at Utah State University had demonstrated the need for competent site facilitators and on-site hands-on activities. As mentioned previously, every site had a trained, competent site facilitator present at all times. Material kits were developed by the principal investigators, participating teacher educators, and the site facilitators. Kits accommodated cooperative learning groups of three to four teachers.

Phase Four: Statewide Follow-up

The purpose of this phase will be to provide a similar program to rural Utah teachers who were unable to participate in the 1994-95 project. The major goal of the follow-up remains to increase teacher understanding of the Utah Core Curriculum for Mathematics and implementation of instructional practices that align with Core goals and objectives. More specifically, the follow-up will:

- facilitate peer multiplier-effect incentives for previous inservice participants.
- provide an appropriate support system to extend inservice offerings.
- increase the feeling of worth among previous inservice participants.

Teacher Implementation of Suggested Reform

A primary goal of the project was to increase teacher implementation of relevant instructional practices in mathematics lessons. The investigators measured change in teaching practices in four ways.

First, in the pre- course survey participants were asked to describe a typical mathematics lesson in their classrooms and to identify sources from which they obtain information for their math lessons. In the post-course survey participants were asked how they have changed their teaching practices as a result of experiences related to this course. The investigators matched participants' responses to the pre- and post-course surveys (See Table 1 for a sample of responses). As evidenced by respondents comments, the course stimulated change in teaching behaviors.

Table 1
Matched Responses to Change in Instruction

Student	Pre-course Lesson Design and Indicated Change in Lesson Design
1	Problem of the day, abstract solving, modeling. **Change:** More hands-on, personal assessment, new concepts and style of teaching students.
2	Graphing how students get to school each day, discussion, drill. **Change:** We need to be a lot more organized and fun, not so much drill and practice.
3	Adding sums using manipulatives. **Change:** Changing by interrelating math to each subject that I teach. I plan to take advantage of every learning situation.
4	Counting exercises, discussion, demonstration using manipulatives. **Change:** I've been using more real-life experiences.
5	Comparing using manipulatives and overhead projector. **Change:** Use math throughout the curriculum and incorporate it into as many lessons as I can. I will use more manipulatives and literature related activities.
6	Discuss lesson plan with students and use pictures to represent operations. **Change:** The one thing that was stressed in this course that I haven't done enough is that math should be related to real life. I have really started thinking about things my students do and using these things to teach mathematics.
7	Graphing using stories and comparing real-life things by making tables. **Change:** I would like to use more things from the child's interests and relate it more to their own lives.
8	Counting games and using manipulatives

Change: I need to take more advantage of teaching moments - real-life situations that come up and then apply math concepts to them.

Second, participants viewed a video vignette at the beginning of the first session and the end of the last session. The vignette highlighted a student sharing activity in a second grade classroom. Participants were asked to identify how the activity could serve as a springboard to introduce mathematics concepts. The investigators compared matched responses from the first and last showings of the vignette to assess change in participants' ability to relate real-world activities to mathematics concepts.

There was a marked difference in both the quantity and quality of participants suggestions for how the student sharing scenario could stimulate relevant activities in mathematics. After the pre-course viewing, the average number of suggestions from participants was four. Suggestions included, "compare coins, separate, group, and graph coins," "where do we use coins, values of coins, start a unit on money."

Responses from the post-course viewing averaged seven suggestions. This represented a 42% increase in the quantity of suggested instructional activities that could be tied to the student sharing activity. The post-course suggestions included many of the same ideas listed on the pre-course surveys with an increase in ideas related to the four operations and interdisciplinary connections. A sampling of suggestions included, "distance (how far away are the countries/map skills, addition/subtraction, measuring weights, sizes," "part/whole concepts, fair trades, greater than/less than, patterns, graphing, history of coins."

Third, participants were asked on the post-course survey to identify how the new Math Core differs from previous Core documents. Since all participants had indicated on the pre-course survey that they were not familiar with the new document, the investigators were able to identify the degree to which the document's emphasis on relating mathematics to daily living had been impressed upon the teachers. Of the 12 teachers that responded to this question, six (50%) indicated that the new Core emphasizes relevant connections to daily living. Five (42%) indicated an increased emphasis on hands-on, manipulative activities. Two (17%) commented on the document's increased emphasis on problem solving skills, and three (25%) noted an increased emphasis on vertical integration of the curriculum.

Lastly, teachers were asked whether they have changed some of their teaching practices as a result of participation in the course. One (6%) of the 16 participants indicated she had not changed her teaching practices.

Effectiveness of the Delivery System

A second major goal of the evaluation was to assess the degree to which the project was successful in integrating hands-on activities into an interactive telecourse format. This goal was assessed in two ways.

First, participants were asked seven questions on the post-course survey designed to assess the effectiveness of the T1 delivery system (See Table 2). In general, teachers indicated that the system was an effective delivery medium, did not limit their understanding of content or the way content was presented by the instructors, and expressed a willingness to take more courses using a similar format.

Table 2
Teacher Attitudes Toward T1 Delivery System

	SA	A	D	SD
As a result of participating in this course:				
I am inclined to take more courses delivered over the T1 system.	15%	62%	15%	0%
I would only take courses delivered over the T1 system if content facilitators and hands-on activities were included.	54%	39%	15%	0%
I felt the T1 delivery system *limited my understanding* of the Math Core, suggested activities, and assessment issues.	0%	7%	54%	39%
I preferred the T1 system over a university course delivered in person.	0%	23%	46%	8%
I felt the T1 delivery system limited *the way information was presented* by the instructor.	15%	15%	70%	0%
I felt I learned as much over the T1 system as I would have if the course was delivered in person.	15%	54%	31%	0%

	A	D	NB
I felt I learned as much over the T1 system as I would have if the course was delivered over ComNet (still video, interactive audio.)	31%	23%	46%

SA=Strongly Agree, A=Agree, D=Disagree, SD=Strongly Disagree, NB=No Bias

Second, the site facilitators and course instructors recorded on video tape comments by participants during all class sessions and during a formal interview at one of the two remote sites. The investigators tallied comments made during the class sessions as being either supportive or unsupportive of the delivery system. Of the 26 comments addressing issues related to the delivery medium, two (8%) were negative. These two comments were related to participant's reluctance to speak and be seen on television. One of the comments was "I didn't know I was going to be expected to talk into a microphone or be seen on TV. I don't like it."

Over half of the positive comments (14) followed the five occasions when a connection to one or the other remote site was temporarily down. Teachers responded with "it's OK, just send us the tape" and "it wasn't very long." In one case when the audio portion was lost, teachers displayed supportive notes on camera. The remaining positive comments (10) expressed enjoyment at being able to "be on TV," the "opportunity to share ideas with other teachers across state," and to play on the eight frame per second transmission and the half second delay between audio and video display at the most remote site.

In the interview, participants were asked to identify strengths and weakness of the delivery system. Three of the four teachers interviewed commented on the value of sharing ideas with other teachers in the state. One teacher commented that "we do things differently in the northern part of the state... I gather most of my good ideas from other teachers and the system provided that opportunity."

Discussion

Clearly, both the curriculum and the delivery system were effective in stimulating change in participants mathematics teaching practices. However, given constraints inherent in mixed-method evaluation methodologies, the limited number of participants in this first course, and the myriad of variables that can effect the success of any instructional approach or delivery system, the investigators are reluctant to make any definitive conclusions about the degree of project effectiveness. Results from the next two course offerings will provide the investigators with a higher degree of confidence on the effectiveness of course curriculum and the delivery model.

At this point, however, we are willing to acknowledge two distinct points. First, it is possible to increase teacher use of relevant instructional practices in mathematics using a telecourse format. Second, it appears that the T1 delivery system can be an effective medium for integrating hands-on, relevant activities if the instructional model incorporates use of trained remote site content facilitators to coordinate on- and off-camera activities. These points are important considerations for those considering developing and implementing collaborative University/Public School inservice projects.

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Designing a Wide Area Telecommunications Network: Factors to Consider

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In the past decade changes have occurred in the field of telecommunications that significantly increase the number of communication methods that are available. In education, as in society, decisions must be made as to how to use limited financial resources to best meet telecommunication needs. Recent advances in technological capability and decreasing costs for this technology have increased the number of communication options that are available to educators. As educational institutions begin to develop their own Wide Area Networks (WANs), the process of designing a network becomes more complex as a result of a wider variety of choices. Most distance learning WAN systems today can be designed with a combination of technologies including satellite, microwave, cable, terrestrial copper and fiber optics. In addition, the WAN will most likely be designed to be compatible with existing Local Area Networks (LANs) made up of computer, telecommunications and video hardware components that will support voice, data and video applications.

The term WAN, although widely used, is often defined in different ways. It is especially important to understand how the term is being defined by all individuals who may be involved in the planning and development of an educational telecommunications network so that problems do not arise as a result of differing expectations. A WAN provides communications connections between sites geographically separated on a telecommunications network and enables remote processing and the facilitation of information sharing and exchange. WANs usually require the use of telecommunications facilities provided by common carriers. Often confusion arises when the term WAN is used to define a Local Area Network/ Wide Area Network (LAN/WAN), or a Local Area Network (LAN). A LAN/WAN is a communications network used to interconnect multiple LANs within a building or campus, or across a large geographic area such as a state, country, or countries. A LAN is a communications network that covers a limited geographic area and allows local terminal, PCs or computer users to share resources such as printers, shared group software, or electronic-mail systems. Examples of commonly used LANs in educational settings include Ethernet and Token-ring. Properly designed WANs can significantly influence the effectiveness of LAN/WAN systems. An example of the relationship between a WAN and a LAN/WAN is illustrated in Figure 1.

The purpose of this paper is to identify issues to consider when selecting common carrier facilities for use in a WAN that will interconnect geographically separate campus locations, facilitating activities or applications such as Instructional Television (ITV), video teleconferencing and distance learning. In addition, a variety of access method options to common carrier facilities will be discussed in relation to their cost and applicability to several commonly used communications applications such as accessing electronic mail, Listserv lists, Internet-based services, instruction via distance learning, and teleconferencing facilities.

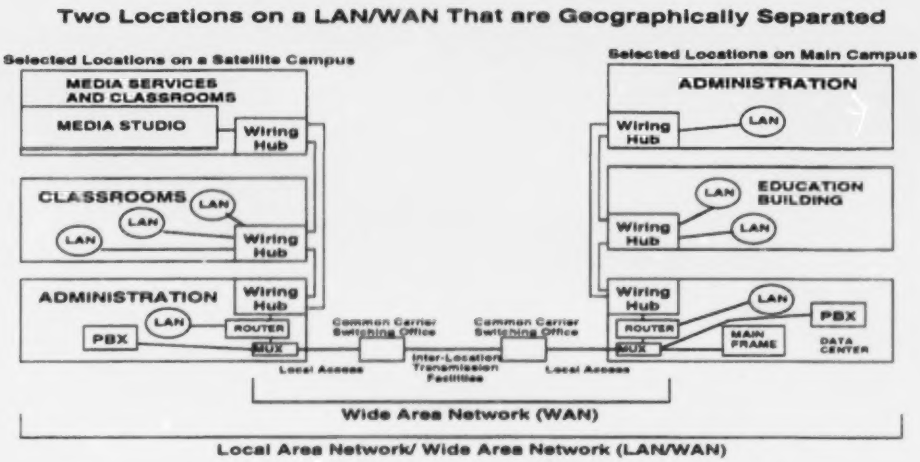
Two Locations on a LAN/WAN That are Geographically Separated
Selected Locations on a Satellite Campus
Selected Locations on Main Campus
MEDIA SERVICES AND CLASSROOMS
MEDIA STUDIO
Wiring Hub
CLASSROOMS
LAN
LAN
LAN
Wiring Hub
ADMINISTRATION
Wiring Hub
LAN
PBX
ROUTER
MUX
ADMINISTRATION
Wiring Hub
LAN
LAN
EDUCATION BUILDING
Wiring Hub
LAN
Wiring Hub
LAN
PBX
ROUTER
MUX
MAIN FRAME
DATA CENTER
Common Carrier Switching Office
Common Carrier Switching Office
Inter-Location Transmission Facilities
Local Access
Local Access
Wide Area Network (WAN)
Local Area Network/ Wide Area Network (LAN/WAN)

Figure 1. A Two Location LAN/WAN Configuration

WAN Design Elements

In order to determine the best set of system design elements to incorporate into a WAN the designer should consider the needs of the users, existing hardware and software that must be engineered into the system, existing campus wiring scheme, budgetary constraints, and the topology of the proposed WAN.

WAN design is largely applications driven. The application needs of the community of interest determines the size and the complexity of the transmission facilities needed to be engineered into the network. Applications such as teleconferencing generate a less complex design and require much less expensive transmission facilities than a system that supports the transmission of data from remote computers, or ITV transmission links. Careful consideration of all of the potential applications that may be supported by the WAN will produce an important set of requirements that will eventually become part of the WAN system design parameters.

In most cases, existing hardware at each site, such as campus telephone systems, computers and modems, will be incorporated into the WAN. Often this equipment poses limitations in terms of compatibility and functionality that must be considered and understood so that the WAN design can support them. In some instances equipment incompatibility may be so great as to prohibit the ability to design anything but limited WAN capabilities. Upon review and assessment of the hardware another important set of WAN design requirements be developed.

Existing wiring schemes can pose severe limitations to the flexibility of WAN designs. Each building that will be connected by the WAN must be evaluated to determine what type of network access can interface with the wiring used for telecommunications. Buildings may only be equipped with standard telephone wire terminated in administrative areas and a few classrooms, while other buildings may have voice and data terminations and in many areas separate wiring for networking computers. Locations with limited wiring plans may not be able to use all of the functionality designed into the WAN. Upgrading wire in buildings can be a costly procedure running into the hundreds, but more often the thousands of dollars per building.

Budgetary considerations also affect the design of a WAN. After reviewing the WAN requirements it is likely that several different components may be required to produce that desired functionality. If the cost for new network facilities, hardware and software, and wiring is more than the budget can support building a WAN may not be feasible.

Major Components of a Wide Area Network (WAN)

A WAN consists of four major components:

1. Inter-location transmission facilities that provide communication links between disparate geographic locations
2. Access facilities between campus buildings as well as WAN access to connect locations to each other
3. WAN interface and termination equipment
4. Software-based protocols that allow for routing and management

Inter-Location Transmission Facilities

Inter-location transmission facilities, provided privately or by common carriers, are the backbone of the WAN. Depending on the distance between locations in the proposed network this service can be provided by a telephone long distance service common carrier, a local operating telephone company, privately owned facilities, or a combination of the three. The network that is comprised of all of the facilities provided by long distance common carriers and local operating companies is also referred to as the Public Switch Telephone Network (PSTN). These service providers offer transmission facilities that support voice, data, or video applications between non contiguous locations. Transmission facilities accommodate the transmission of information in much the same manner that plumbing pipes accommodate the transmission of water. Transmission facilities should be selected that have the capacity to handle efficiently all of the desired applications serviced by the WAN, but not have too much extra capacity. Excessive unused capacity on a network results in unnecessary cost.

Transmission facility capacity requirements are developed by calculating the length of a typical message sent over a given time period. Factors to take into consideration are:

1. Message Size
2. Whether transmission patterns will be fairly constant or bursty
3. Wether the use of facilities will be full time or part-time
4. The number of locations that will be connected to each other
5. The expected response times
6. Whether an application has a minimal bandwidth requirement

For example, LAN interconnections generally facilitate medium to large messages (10 kbytes-100 kbytes) in bursty transmission patterns, full time between many-to-many users at expected high response times. LAN interconnections generally would require facilities with a bandwidth of at least 56Kbps up to 1.5Mbps. Video transmission might require facilities to accommodate very large messages (1 mbyte and over) delivered at constant patterns, part-time, one-to-one or one-to-many/few with an expectation of a high response time. Video transmissions generally require 128-768Kbps for limited motion applications and 1.5Mbps or higher for full motion applications. Terminal-to-Host applications generally require facilities that accommodate small (under 1 kbyte) to medium messages with bursty transmission patterns, in full time use with many-to-one connectivity with a relatively low response time objective. Terminal-To-Host applications usually require bandwidth of 56Kbps or less.

Inter-location transmission facilities fall into two broad categories: usage sensitive and non-usage sensitive facilities. Usage sensitive facilities are facilities the user pays for on a per occurrence of use basis. Non-usage sensitive facilities are facilities that are available to the user 24 hours per day either on a contractual or monthly basis. The following is a selected sample of some of these facilities and an explanation of their purpose.

Non-Usage Sensitive Facilities Provide by Transmission Vendors (Common Carriers)

Voice grade telephone lines: The common line that is connected to most telephones. It is designed to handle simultaneous voice transmissions, but is often used to transmit limited data transmissions at up to 19,200 Kbps. These lines are useful for creating temporary connections from PCs with modems to local computer hosts as well as providing access for teleconferencing services. These facilities are usually non-usage sensitive for local calling only. The cost for these lines is relatively low ranging from $30 to $65 per month for service. Long distance calling would accrue an additional per minute charge.

Private lines (Leased lines): Transmission facilities that are connected directly to a location by a network common carrier. Private lines are designed to carry voice or data traffic or a combination of the two. Since private lines are dedicated facilities they are always available and cost effective when there are enough applications being used on the facility to occupy most of its capacity a large percentage of the time. Private lines are available in speeds ranging from 9.6Kbps to 45Mbps. They make very good connections for all types of applications that may be transmitted via WAN including, e-mail, terminal-to-host, Internet-based, LAN interconnectivity, and video. The cost of a private line is determined by its length and the proximity of each location that is connected to the common carrier's nearest central office. A 9.6Kbps private line of only a few miles in length may range in cost from $200-$500 while connections that are 50-100 miles in length might cost $500-$1,000 monthly. Larger capacity circuits carry correspondingly higher per month prices. A 1.5Kbps circuit may range in price from around one-thousand dollars for a short length circuit to many thousands of dollars for a much longer connection.

Non-usage Sensitive Transport Facilities Owned by the End User

Microwave: High-frequency radio waves used for point-to-point and omni-directional communication of audio, video and radio signals. Microwave requires line-of-sight to operate properly and is affected by rain and other atmospheric conditions. Microwave is often used for television broadcast applications between locations that are relatively close together (under 25 miles depending on the line of sight, longer if equipment call repeaters are strategically placed along the transmission path). Microwave equipment can cost from a few thousand to tens of thousands of dollars in one-time cost per location to set up a system. Systems can also be leased from common carriers and others on a contractual basis for several hundred to several thousand dollars per month depending on the size of the equipment and the length of the contract.

Private coaxial or fiber optic cable: Shielded wire or fiber optic cable commonly used in television transmission. Private coaxial or fiber optic cable can be used in much the same way as private line for WAN interconnections and can be leased from local cable companies at prices comparable to private line prices. Coaxial or fiber optic cable makes excellent backbone for inter-building campus wiring schemes but is limited in use in that installing this type of cable can cost hundreds of dollars per foot.

Usage Sensitive Facilities Provided by Transmission Vendors

Virtual private line-X.25: Packet switched service that maximizes dedicated access facilities by switching information in small "packetized" sections. The service is a data only application. X.25 can be used for data applications in the same manner as private line and cost $200-$500 for access, plus a usage charge of approximately 75 cents per kilopacket. An advantage of this service over private line is that packets can be sent to mutliple destinations from one originating location.

Virtual private line-Frame Relay: Packet based service similar to X.25 with improved performance. It is a data only service and cost approximately $250-$1000 per location.

Virtual private line-Asynchronous Transfer Mode (ATM): High speed packet switched service that provides a constant bit rate function which allows the transport of voice, data and video, ATM is not yet widely available and has no current market price.

Dial-up switched 56: Each location is provided a unique address (such as a phone number) which enables a network provider to connect two points together for a specific period of time. Transmission speed is 56kbps which can be used for voice, data or low speed video. This service is a good choice for periodic uses such a slow speed videoteleconferencing, batch downloads between mainframes and infrequently used applications that require moderately large bandwidth. Dial-up switched 56 service cost approximately 30 cents per minute.

Access Facilities

Access facilities are connections that provide a transmission path from the Local Exchange Carrier's public switched telephone network to each location on the WAN. A WAN connection requires an access connection at each end terminating in the local exchange carrier's nearest transmission switching office with an interoffice channel connecting the two offices together. See Figure 2.
This confusing setup is the result of Divestiture and the break-up of the Bell System approximately 10 years ago. As a result of divestiture, in most instances, only local operating companies can provide access to the PSTN. A variety of companies can provide the interoffice channel portion. As a result, it is likely that connections on a WAN could be provided by several service providers.

Within the PSTN is a sub-network called the Integrated Switched Digital Network (ISDN). ISDN is an end to end digital network that enables a user to send data, voice and audio transmission signals over the same line simultaneously. ISDN has the benefit of providing greater transmission integrity by providing end-to-end digital transmission connections as compared with transmissions on the regular PSTN that may be converted from digital to analog signals, or vice versa, several times in one transmission.

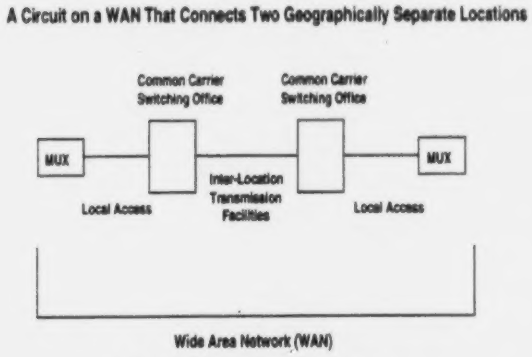
A Circuit on a WAN That Connects Two Geographically Separate Locations
Common Carrier Switching Office
Common Carrier Switching Office
MUX
MUX
Local Access
Inter-Location Transmission Facilities
Local Access
Wide Area Network (WAN)

Figure 2. A WAN Circuit

ISDN Basic Rate Interface (BRI): Provides two information channels at 64Kbps and one 16Kbps management channel over a single pair of local exchange facilities on a dial up basis that can be used for voice, data or video. BRI provides outstanding transmission quality for any data or video application. In addition, it provides an access path that enables the user to monitor the transmission performance . BRIs would be a good choice for an Internet access line that would be used frequently to download or upload heavily graphic or motion-clip rich documents that reside in applications such as Mosaic. The cost of BRIs ranges from 150-200% of the cost of a regular voice grade telephone line.

ISDN Primary Rate Interface (PRI): Provides 23 information channels at 64 Kbps and one management channel over dedicated access facilities at 1.544 Mbps. This service is a good choice for high volume applications. PRI would make a good choice to carry Instructional Television, video teleconference or full motion video applications between sites with frequent activity. The cost of PRIs ranges from approximately $1,000-$1,500 per month.

Private line (Leased Lines): These facilities are described in the non-usage sensitive transmission facilities section.

Public Switched Telephone Network Interface Equipment

Routers, brouters: Devices designed to route packetized information through networks and reconstruct the information at the termination point. Routers and brouters also have addressing capabilities. These devices cost one to several thousand dollars each.

Muxes: Devices that take multiple lower speed inputs and create a single higher speed output for transport. The price of muxes are price similar to Routers, brouters.

Asynchronous Transfer Mode (ATM) switches: Devices that packetize voice, data and video signals and hand off the information to a high speed network for transmission. These switches cost tens of thousands of dollars.

Digital Access Cross Connect (DACS) units: Used in digital networks to electronically connect virtual and dedicated networks. DACS units cost tens of thousands of dollars.

Synchronous Optical Network (SONET) Interface units: Provide high speed connections for voice, data and video at speeds above 45Mbps. These interface units cost several thousand dollars.

Digital Service Unit/ Channel Service Unit (DSU/CSU): Equipment which provides interface from a local digital facility to customer's equipment. These units cost approximately one thousand dollars, but may be provided free by some inter-exchange common carriers.

Termination Equipment

Termination equipment defines any device that is used for final output of transmission including such units as telephones, computers, facsimile machines, video displays and other terminating devices.

Software Based Protocols

Transmission Control Protocol/ Internet Protocol (TCP/IP): A standards based method of moving data over a local or wide area network.

Frame relay: The preferred high speed packet network which virtually connects client/server networks in a point-to-point, or mesh arrangement.

Cell relay Asynchronous Transfer Mode (ATM): Integration of voice/data/video over a high speed network utilizing fixed length packets.

ISDN broad band (B-ISDN): High speed ISDN. Works similar to ISDN Primary Rate Interface at higher speeds.

Other Issues to Consider

A WAN/LAN may carry a combination of educational and administrative applications. If mission critical functions are to be placed on the WAN, then redundancy, accuracy and reliability must be stringently addressed in the design of the network. Disaster recovery plans need to be developed, and data back up functions should be included in the plan.

The expertise to configure and maintain a WAN may not exist within the WAN user community. Typical PC literate individuals may know little or nothing about WAN network design and management. It may be necessary to use the services of a private consultant who specializes in network design to configure an efficient network. Network vendors also provide network design and consulting services usually at no charge. Network vendors tend to recommend the services that they provide.

Conclusion

Designing a wide area network that meets the needs of a diverse group of users requires careful planning. A well designed wide area network that carries a mix of voice, data and video applications will be made up a variety of hardware and network transport components. There are a variety of transmission options available that can significantly improve the performance and reliability of the applications that may be communicated on the system. Careful consideration of the requirements of the users and the options available can insure that a well designed WAN/LAN will result.

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Teaching Teachers to Use Telecomputing Tools: Formats and Tips

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Do you teach teachers to use telecomputing tools? If so, you may have discovered that *this* kind of inservice training is different from other types of educational computing instruction. Why? The nature of the tools and their potential uses is different. Whether teachers will choose to use telecomputing innovations for professional development and/or instructional purposes depends more upon *other* teachers' use of the tools than upon the characteristics of the innovations themselves.

How Telecomputing Tools are Different

The process by which teachers either adopt or reject use of telecomputing tools is one example of the *diffusion of innovations.* Everett Rogers (1986) has qualified his well-known previous work in this area (Rogers, 1983) to address the special nature of the diffusion process that occurs when communications innovations are introduced into a social system. His meta-analytic synthesis of communications studies' results revealed three ways in which the adoption of interactive communications innovations differs from similar processes with other innovation types.

1. A *critical mass* of adopters must be using the innovation to persuade potential adopters to do the same; "the usefulness of a new communication system increases for all adopters with each additional adopter" (Rogers, 1986, p. 120). Telecommunications networks will not readily be used by teachers until a noticeable community of educators, and/or information resources designed specifically to support precollege education, are present online.

2. The *degree of use* of a communications innovation, rather than the decision to adopt it, is the dependent variable that will indicate the success of the diffusion effort. Teachers will continue to use *internetworked* tools and resources, once introduced to their application, only if they use them regularly and frequently *now.*

3. New communication technologies are *tools,* which can be applied in many different ways and for different purposes. Therefore, adoption of these innovations is an active process that involves much *re-invention,* or "the degree to which an innovation is changed or modified by a user in the process of its adoption and implementation" (Rogers, 1983, pp. 16-17). Teachers will continue to use telecomputing tools in the classroom only if they are successful in designing professional development and instructional activities that employ unique and personalized use of the tools that meet specialized needs.

The importance of re-invention must not be overlooked by those of us responsible for teaching others how to use telecomputing tools in educational contexts. Innovations that are more flexible, with many possible applications (like telecommunications innovations), and those that are shared via a decentralized diffusion network (like telecomputing tools), are more likely to be re-invented than those that are less flexible or are diffused according to a centralized plan (Rogers, 1986). Also, re-invention appears to be very important psychologically to adopters of such innovations (Rogers, 1983); adopters must take the innovation and "make it their own" if use of the innovation is to continue. When helping teachers to learn to use telecomputing tools, we must anticipate, stimulate, and encourage teachers' re-inventions of telecomputing applications. One approach to supporting re-invention of telecomputing tools is to provide multi-disciplinary and cross-grade *activity structures* (Harris, 1994a; 1994b; 1994c) as models for activity design. In this way, teachers can function more as instructional designers than lesson planners.

Likely Innovation Adopters

Rogers' review of many communications studies indicates that generally, only 10 percent of the users on any one network contribute approximately 50 percent of all of the online "traffic." The other 90 percent of the users contribute the other 50 percent (Rogers, 1986). This implies that if we want telecommunications innovations to be used in powerful ways in precollege learning environments, we need not attempt to convince every teacher...or even the majority of teachers...to use them. Instead, Rogers suggests, we should target the *opinion leaders* within the social system of the school or district.

How can you tell which teachers are opinion leaders? According to Rogers, opinion leaders:

1. are more exposed to all forms of communication outside the social system,
2. are more cosmopolitan than other members of the social system,
3. have somewhat higher social status than other members of the social system,
4. are more innovative, when compared with the system's norms,
5. have unique and influential positions within the system's existing communications networks,
6. and can not be too much like the *change agents*, or those teachers or administrators who are actively trying to convince others to use the innovation, if they are to be trusted and emulated by their peers (Rogers, 1983).

This implies that access to telecomputing resources and support for their use, in the forms of training, ongoing assistance, funding, and, most importantly, *time*, should be concentrated upon those opinion leaders within each school who are most willing to explore professional development and instructional use of internetworked tools. Rogers' work tells us that as these opinion leaders become comfortable and competent on the Information Highway, they will, by their example in daily practice, bring along, by personal influence, those colleagues who were initially reticent to explore new uses of new tools in the classroom. This "grass roots" pattern of innovation diffusion may appear to be slower and less comprehensive than traditional "top down" implementations, but it is, overall, a more effective plan, because it complements the natural ways in which new tools are adopted by members of social systems. In the next section instructional formats that support diffusion of innovation will be examined.

Forms of Telecomputing Training

The Internet is a huge decentralized network of networks (of networks...) that currently serves more than 20 million users and encompasses more than 3 million hosts worldwide (Quarterman, 1994). It is growing at the rate of approximately 80 to 100 percent per year (Quarterman, 1993; 1994), changing literally minute to minute. To use the Internet for both professional development and instructional purposes requires constant accommodation to rapid change, successful use of varied interfaces, and, most importantly, *tolerance for ambiguity*. These prerequisite attitudes and skills cannot be taught directly; rather their development can be assisted by offering relevant instruction in appropriate formats to willing participants.

Black (1994) suggests that Internet training be offered according to one of two formats: the *power workshop* or the *progressive workshop* (p. 45). The power workshop, which meets for one or more consecutive full days, allows participants to discover what is available and of interest on the Internet. The detailed and extensive documentation that Black and her colleagues provide support participants in continued, but independent, participation once the workshop is over. The progressive workshop, which meets periodically for six weeks to nine months, usually at the rate of three to five meetings a month, allows participants to explore different kinds of Internet resources in a more individualized, better supported, and less intensively paced format. Participants meet face-to-face for 60-90 minutes at a time, then go home to practice their new skills in an asynchronous, assisted manner. Black points out that the progressive workshop format can allow participants to select topics of interest from a variety of session content options. Yet she also asserts that the optimal scenario is one in which learners first attend a power workshop, then participate immediately afterwards in a progressive workshop. In this way, teachers can experience the desirable aspects of both workshop types.

Intensive ("power") and/or paced ("progressive") online learning and teaching usually take one of eight forms, listed and described below.

Independent Learning

Many Information Highway travellers who are teachers have learned to use telecomputing resources independently, with little assistance. This is probably the most time-consuming and frustrating way to learn, due to the highly ambiguous and changing nature of the Internet, and the cumbersome characteristics of many of the procedures that are presently necessary to navigate in cyberspace.

Independent Learning with Remote Assistance

Most teachers who presently use internetworked tools have learned to do so by applying patience, persistence, and good problem-solving skills both independently and with assistance from more experienced network enthusiasts. Since there are so few teachers presently with access to the Internet, an estimated 0.5% of all Internet account-holders (Harris, 1994d), this is the most prevalent, but not necessarily the most efficient, format for learning to use telecomputing tools.

One-to-One "Coaching"

Some teachers are lucky enough to work or live in close proximity to a more experienced "Internaut" who is willing to provide telecomputing training informally on an individualized basis. As communities of telecomputing teachers are formed within existing social systems, this very effective format for learning to use internetworked tools will become more commonplace.

Large-Group Demonstration with Independent Practice

This format for teaching teachers to use telecomputing tools is often employed in the early stages of a school's or district's adoption of telecomputing innovations. Demonstrations of Internet resources and tools that are useful for professional development and/or instruction are typically made to large groups of (usually) impressed teachers and administrators. Unfortunately, these demonstrations rarely communicate the significant challenge that independently learning to access and use telecomputing resources and tools predicts. Therefore, this format is more effective in marshalling support from decision-makers than in helping teachers to truly use internetworked resources.

Large-Group Demonstration with Assisted Practice

This format improves upon the previously-mentioned idea, in that it can be effective both in convincing decision-makers to provide for the infusion of telecomputing tools into educational contexts, and in helping teachers to make use of the provisions, once they are in place. However, it is generally not as successful overall in terms of the diffusion of telecommunications innovations as are the following three organizational structures.

Hands-On Lab, Intensive Schedule

It is probably no surprise to the readers of this paper that teaching teachers to use new computer-mediated tools in a hands-on, collaborative context, in which brief demonstrations are followed immediately by assisted exploration of the procedures demonstrated, is, in many situations and for many purposes, the most effective way to offer telecomputing training. Teachers' schedules make the available time for such hands-on experiences quite limited, though. An *intensive schedule* (i.e., several half-day or full-day sessions on Saturdays) is most often used for hands-on training, but due to the overwhelming amount of information available for educational use on the Internet, and the multiple skills necessary to master effective access and use of that information, this may not be the most facilitative type of telecomputing training for teachers.

Hands-On Lab, Paced Schedule

Spreading hands-on experiences evenly over several months of Internet work is preferable to planning labs according to an intensive schedule. This option allows teachers to practice the skills that they learned in a face-to-face environment both independently and/or with individualized, asynchronous assistance before encountering the next new skill or resource type. It is difficult to assure that the between-meetings work gets done. Given the many professional and personal demands upon teachers' time, without structuring participants' expectations before they agree to participate.

Hands-On Lab, Paced Schedule, with Structured Online Activities

Although this model for teaching teachers to use telecomputing tools is the most effort-intensive option for telecomputing trainers, it is probably the most effective overall. If highly interactive, hands-on sessions offered at regular intervals in lab settings are supplemented by structured, motivating online activities, to the completion of which participants have committed before instruction begins, and for which the participants see themselves as responsible, online *communities* of networked teachers can emerge. Whether or not these communities continue to function (either intact or in expanded forms) after training activities end depends upon the extent to which individual participants have truly adopted telecomputing innovations. The success of this particular training model, in terms of helping teachers to develop transferable and longitudinal Internetworking skills, attests to the growing popularity of the "online course."

It is important to remember that different conditions of access to, purpose(s) for, and support for use of telecomputing tools and resources will greatly affect the choice of training format(s) most appropriate, time-effective, and cost-efficient for use with potential telecomputing teachers within a particular teaching/learning context. The descriptions above are offered as an array of possibilities, rather than a hierarchy of recommendations. They are also admittedly unfinished, as new structures will undoubtedly emerge as increasing numbers of teachers and students learn to use the Internet. New tools require new techniques for training, incorporated into new models of teaching and learning processes, if the tools' most powerful attributes (Clark, 1983) are to be exploited.

Top Ten Tips for Teaching Teachers

In closing, and with apologies to David Letterman, I offer ten "tips" for those of you responsible for teaching teachers to use telecomputing tools. Unlike many of the suggestions offered earlier in this article, these tips are not based upon the results of research; rather, they emerge from several years of work with teachers from many different locations who were learning to use internetworked tools and resources for professional development and instruction. These "top ten tips on teaching teachers to use telecomputing tools" are listed in no particular order below.

1. Ensure teachers' *access* to telecomputing tools and resources before attempting to teach them to use them. If possible, provide easy access both at school and at home.

2. Access to *all* types of Internet resources is essential. At present, this should include electronic mail, some sort of computer conferencing (i.e., newsgroups or electronic bulletin boards), direct ("Telnet") connections to remotely located information resources, file transfer capabilities to and from anonymously accessible file archives on the Internet, Gophers and related tools, such as *veronica*, and, if possible, World Wide Web tools, such as *Mosaic*.

3. Telecomputing trainers should be local, longitudinal, and "lancemen." In other words, these folks should be part of the existing social system of the school or district, they

should be available long-term for ongoing support of telecomputing adventures, and they should be seen as "one of the guys/gals," rather than the local computer guru.

4. Introduce new users to electronic mail (for private or small-group communications) and computer conferencing (for public and larger-group communications) *first* and *together*. Although as a trainer, you may be most excited about getting information resources into the hands of your teacher-students, remember that they will feel most comfortable with those tools whose use most closely resembles communication forms with which they are familiar, such as the letter and the bulletin board or committee meeting. Also, it is important that new telecomputing teachers understand the varied (and most efficient) uses of differing tools, so that they will use each for the purposes for which it is best designed.

5. Introduce Gophers, Telnet sites, FTP archives, and World Wide Web tools *later* and *as interests dictate*. Remember that teachers' successful use of telecomputing tools will be highly individualized and, to use Rogers' term, *re-invented*. There is a much better chance that teachers will use internetworked tools and resources in powerful and ongoing ways if they are *ready* for "something new" when you introduce it, and self-motivated to use the new technique for self-determined purposes.

6. Make clear, friendly, paper-based, *user-developed* documentation amply available to trainees. There is no better teacher (or document writer!) than another, slightly more experienced, teacher. Be cautious of adopting documentation written by technical specialists, and be willing to coordinate the ongoing revision and updating of participant-created documentation.

7. Provide structured, enjoyable online activities for practice of skills learned in face-to-face, hands-on sessions. Remember that adults learning new skills are much like children in that they are most receptive to playful learning environments.

8. After users are comfortable with telecomputing tools, provide *activity structures* that can be used to design curriculum-based telecomputing applications. Examples of such structures, along with activities created and field tested by telecomputing teachers, are presented in the three articles in *The Computing Teacher* listed in the references at the end of this paper.

9. Encourage teachers to use resource guides, rather than making them responsible for finding online resources for professional development and instructional use. The *Internet Resource Directory for Educators*, one example of such a guide, is available for anonymous file transfer at: **tcet.unt.edu** in the subdirectory: **pub/telecomputing-info/IRD**.

10. *Fully* support "eager beavers," or those teachers most motivated to explore the Internet, allowing use to grow in grass-roots patterns. Simultaneously, make sure that there is "support from above:" from school, district, and/or state decision-makers. Do *not* mandate participation in telecomputing training sessions!

Sound straightforward and easy to implement? If so, please remember the following:

> *The difference between* theory and practice in practice
>
> *Is greater than the difference between theory and practice in theory.*

- Anonymous

That said, and despite the usual challenges that confront the creators of the best-laid plans for change, please accept my wishes for success as you continue to teach teachers to use telecomputing tools.

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Evolution of the Teacher Education Internet Server

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Jerry Willis
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In 1993, the Teacher Education Internet Server (TEIS) was developed as an online resource for educators seeking to more effectively integrate technology into teacher education programs. Telecomputing networks have been experiencing explosive growth in recent years. TEIS was designed to capitalize upon this evolving technology in ways that would benefit teacher education programs at colleges and universities around the world. Originally, named the STATE (Society for Technology and Teacher Education) Teacher Education Server (Robin, Bull, Sigmon, and Mitchell, 1993), TEIS is a collaborative project supported by the Society for Information Technology and Teacher Education (SITE), the University of Virginia, and the University of Houston and is a free resource to the entire Internet community.

TEIS is made up of two components, a gopher site which houses archived information and materials and an interactive side. A variety of archived documents are available on the TEIS gopher including text and word processed versions of the *Technology and Teacher Education Annual*, the *Journal of Technology and Teacher Education* (JTATE) abstracts, and issues of *Interface*, an IBM-sponsored newsletter aimed at technology-using teacher educators. A series of "Teach-IT" modules, instructional materials on various subjects in educational technology are available for downloading. Also, downloadable IBM and Macintosh educational software is on the server including some of the more popular graphical-user-interface Internet tools and some excellent multimedia examples provided by the University of Maryland which demonstrate how hypermedia can be developed and used in K-12 education.

TEIS interactive resources allow users to communicate with *other teacher educators* who have similar interests. The interactive services of TEIS allow users to:

- access online discussion groups which cover various content areas within teacher education
- send comments and request information from the editor of the *Interface* newsletter
- request information about the Society for Information Technology and Teacher Education

A built-in telnet function allows users to access the interactive resources of the server. The user is prompted to enter a TEIS User ID. If you are not a registered user, you may browse through the system as a guest or establish your own TEIS account. Establishing your own TEIS account allows you to participate in the online discussion groups available on the server. Accounts may be created by following a series of on-screen prompts which guide you through the registration process.

Focus on Content Areas

TEIS is still in the development stage and work is underway to focus the server on specific content areas and less on technology itself. As part of this development, students and faculty at the University of Houston and the University of Virginia are working to expand the capabilities and available resources of the server. TEIS relies on volunteer "curators" for maintaining and administering the specific content areas of the server. Currently, curators are developing materials in the areas of Math, Language Arts, and International education. However, it is hoped that groups of content specialists will work together to discuss important issues and develop innovative ways to utilize technology in the field of teacher education.

The challenge for any online resource today is trying to maintain an individual identity in the midst of the staggering number of resources which now populate the Internet. The hope of the TEIS team is that this resource will stand out as an online reserve of material specific to the integration of technology into teacher education. TEIS is an attempt to create an online identity which encompasses the field of technology and teacher education. But this can only be accomplished with the support of educators throughout the world who are able to share their work and their ideas with their colleagues.

Connecting to TEIS

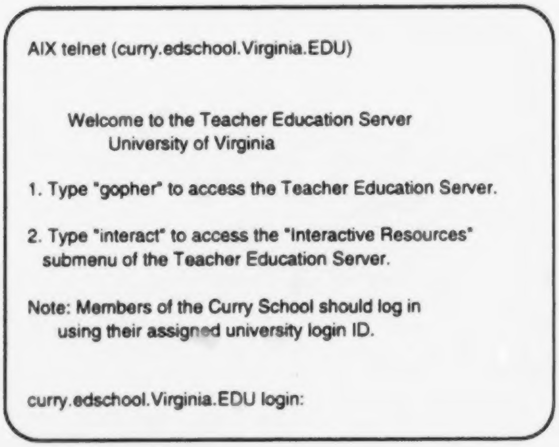
As the Internet has continued to grow, so too have the methods for connecting to the Teacher Education Internet Server. A number of different options now exist for accessing the server, including Telnet, gopher, and the World Wide Web. Each method is described below.

Connecting via Telnet

Practically all university computing systems offer their users access to standard Internet Telnet capability. This method is not recommended however, unless it is the only way of accessing the server available to you. To access TEIS via Telnet, you will enter the following command from your system prompt:

```
telnet teach.virginia.edu
```

Once the connection has been made, you will be prompted to type either "gopher" or "interact" to access either component of TEIS as shown below in Figure 1.



```
AIX telnet (curry.edschool.Virginia.EDU)


      Welcome to the Teacher Education Server
             University of Virginia

1. Type "gopher" to access the Teacher Education Server.

2. Type "interact" to access the "Interactive Resources"
   submenu of the Teacher Education Server.

Note: Members of the Curry School should log in
      using their assigned university login ID.


curry.edschool.Virginia.EDU login:
```

Figure 1. The TEIS Login Screen

Connecting via Gopher

On most university computing systems, gopher software is available which allows users to access gopher sites around the world. Depending on the type of Internet connectivity available at your site, you may be using ASCII text-based gopher software or a graphical-user-interface (GUI) application to connect to TEIS. If you are using a text-based gopher application, you will need to enter the command which brings up the gopher program. At some universities where a mainframe network system is used, at the system prompt, you will type a command such as:

access gopher

and, after pressing the Return Key, then type

gopher

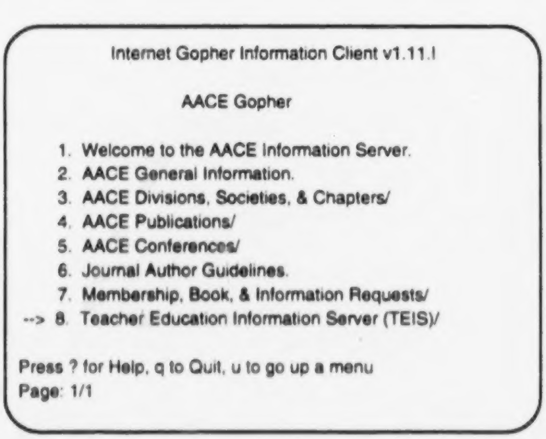
At other locations, you may simply type the word "gopher" at your network prompt to bring up your university's gopher menu. Once you have accessed your university's gopher menu, you may follow the gopher search path:

North America/
USA/
Virginia/
TEIS/

Or, with some university gopher systems, you may type the letter "o" which allows you to connect to another gopher, provided you know the address of the new gopher server you want to access. The gopher address for TEIS is the same as the telnet address:

teach.virginia.edu

Once you establish the connection, you will see the gopher menu of the AACE (Association for the Advancement of Computing in Education) which shares its home with TEIS. TEIS is the last choice on the AACE Gopher main menu.



```
             Internet Gopher Information Client v1.11.1

                           AACE Gopher

       1. Welcome to the AACE Information Server.
       2. AACE General Information.
       3. AACE Divisions, Societies, & Chapters/
       4. AACE Publications/
       5. AACE Conferences/
       6. Journal Author Guidelines.
       7. Membership, Book, & Information Requests/
-->    8. Teacher Education Information Server (TEIS)/

Press ? for Help, q to Quit, u to go up a menu
Page: 1/1
```

Figure 2. A Text-Based Gopher Screen

If you have Internet connectivity which supports graphical gopher applications, you can take advantage of a client-server connection on your desktop computer. The basic content of TEIS will be the same, but additional features will make it easier to use. Using software applications such as TurboGopher for the Macintosh or HGopher or WSgopher for computers running Windows, you will be able to take advantage of the "point and click" features the Graphical User Interface (GUI). Figure 3 shows the AACE gopher menu accessed with a GUI gopher application.

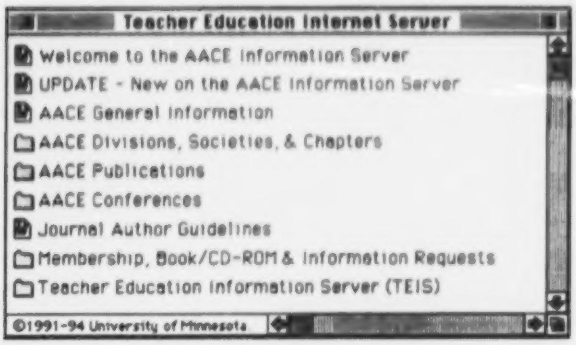
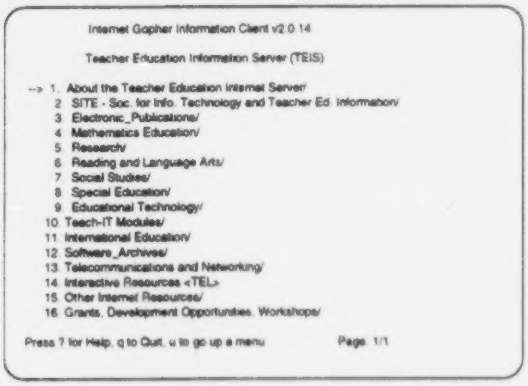

Teacher Education Internet Server
Welcome to the AACE Information Server
UPDATE - New on the AACE Information Server
AACE General Information
AACE Divisions, Societies, & Chapters
AACE Publications
AACE Conferences
Journal Author Guidelines
Membership, Book/CD-ROM & Information Requests
Teacher Education Information Server (TEIS)
©1991-94 University of Minnesota

Figure 3. A Graphical Gopher Screen

Once you have accessed TEIS, you will see the main gopher menu in either a text or graphical mode as shown in Figures 4 and 5.



```
          Internet Gopher Information Client v2.0.14

          Teacher Education Information Server (TEIS)

--> 1. About the Teacher Education Internet Server/
    2. SITE - Soc. for Info. Technology and Teacher Ed. Information/
    3. Electronic_Publications/
    4. Mathematics Education/
    5. Research/
    6. Reading and Language Arts/
    7. Social Studies/
    8. Special Education/
    9. Educational Technology/
   10. Teach-IT Modules/
   11. International Education/
   12. Software_Archives/
   13. Telecommunications and Networking/
   14. Interactive Resources <TEL>
   15. Other Internet Resources/
   16. Grants, Development Opportunities, Workshops/

Press ? for Help, q to Quit, u to go up a menu              Page: 1/1
```

Figure 4. The Text-Based TEIS Gopher Screen

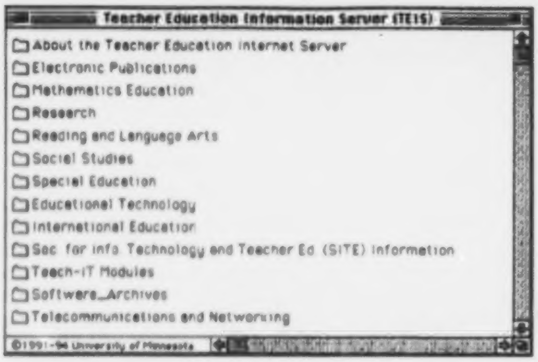

Teacher Education Information Server (TEIS)
About the Teacher Education Internet Server
Electronic Publications
Mathematics Education
Research
Reading and Language Arts
Social Studies
Special Education
Educational Technology
International Education
Soc. for Info. Technology and Teacher Ed. (SITE) Information
Teach-IT Modules
Software_Archives
Telecommunications and Networking
©1991-94 University of Minnesota

Figure 5. The Graphical TEIS Gopher Screen

Connecting via the World Wide Web

In just the last few years the WWW has become the most widely used information distribution system on the Internet. The "Web" supports a wealth of resources that incorporate hypertext and multimedia features. Mosaic and Netscape (available for Macintosh, Windows and X Windows) are the preferred browsers for most users. They provide a consistent graphical interface and seemingly universal access to a variety of information and media in a simplified, consistent fashion.

Because it can also be used to access other Internet resources such as gopher sites, FTP (file transfer protocol) sites, Telnet, and USENET newsgroups, the World Wide Web has been called the first true global hypermedia network (Hughes, 1994). Another advantage of using the Web for information retrieval and access is that Web browsing software such as Mosaic and Netscape use "helper applications" which allow users to easily view different types of graphics, listen to sound files, and even play QuickTime video movie clips.

With the proliferation of WWW sites on the Internet, TEIS has begun exploring the potential use of this medium A prototype WWW Home Page has been developed and is currently being tested. Every Web site has a URL, or Universal Resource Locator, which serves as it's Internet address. The URL for TEIS is:

http://teach.virginia.edu/teis/

The prototype TEIS Home Page accessed via Netscape's WWW browsing software is shown below in Figure 6.

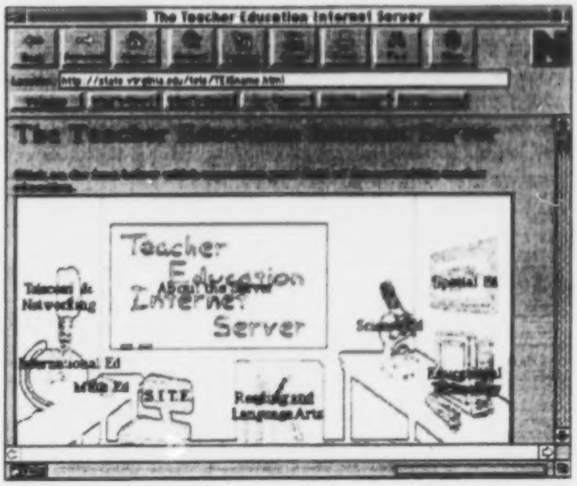
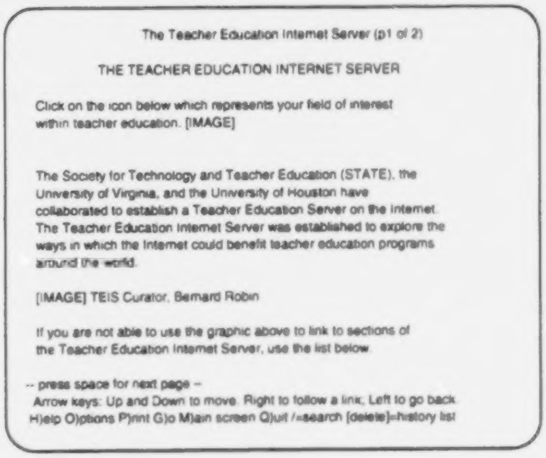

The Teacher Education Internet Server
The Teacher Education Internet Server
Teacher Education Internet Server
About the Server
Telecom & Networking
Special Ed
Science Ed
International Ed
Math Ed
S.I.T.E.
Reading and Language Arts

Figure 6. The TEIS WWW Home Page

Connecting via Lynx

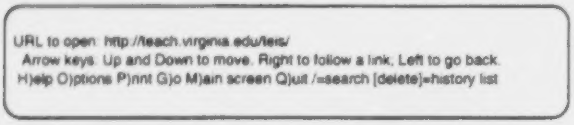
For users who do not have Internet access which supports WWW hypertext browsing software, a text-based Web browser is available. The Lynx software program provides a user-friendly hypertext interface for users of mainframe computing systems, and allows access to the hypertext portion of WWW documents. The advantage of using Lynx to access WWW pages is that it is more widely available to those with basic Internet connectivity. Lynx can be run over a modem link to a terminal server. The major disadvantage of using Lynx is that only the text portion of the Web page is viewable. Graphics are not displayed and the word "Image" appears wherever a graphic is located in the original Web document. The TEIS Web Page, accessed with Lynx, is shown below in Figure 7.



```
                    The Teacher Education Internet Server (p1 of 2)

              THE TEACHER EDUCATION INTERNET SERVER

   Click on the icon below which represents your field of interest
   within teacher education. [IMAGE]


   The Society for Technology and Teacher Education (STATE), the
   University of Virginia, and the University of Houston have
   collaborated to establish a Teacher Education Server on the Internet.
   The Teacher Education Internet Server was established to explore the
   ways in which the Internet could benefit teacher education programs
   around the world.

   [IMAGE] TEIS Curator, Bernard Robin

   If you are not able to use the graphic above to link to sections of
   the Teacher Education Internet Server, use the list below.

-- press space for next page --
  Arrow keys: Up and Down to move. Right to follow a link; Left to go back.
 H)elp O)ptions P)rint G)o M)ain screen Q)uit /=search [delete]=history list
```

Figure 7. The TEIS Web Page Accessed with Lynx

Another factor in using the Lynx software is that it must be installed on the UNIX or VMS system through which you get Internet access. Many university computer systems now have Lynx installed and operational but you will need to contact your computing center to find out if it is available at your location. As with the graphical WWW browsers, you will still need to know the URL for TEIS to establish a Lynx connection. By typing "G" to Go To a new location, you will be prompted to enter the URL as shown below in Figure 8.



```
URL to open: http://teach.virginia.edu/teis/
  Arrow keys: Up and Down to move. Right to follow a link; Left to go back.
 H)elp O)ptions P)rint G)o M)ain screen Q)uit /=search [delete]=history list
```

Figure 8. The Go Command in Lynx

Where Do We Go From Here?

Even though it is far from perfect, the World Wide Web certainly offers an attractive starting point for educators who are interested in becoming part of a globally-linked hypermedia network. Because Web home pages can contain hypertext links to other home pages, a series of teacher education documents can be developed and maintained at sites around the world. In the early phases of this evolution of a global graphical hypermedia network, a British Teacher Education home page has been developed. It is significant that it was developed and resides on a computer in the United Kingdom and is linked to the main Teacher Education Internet Server computer which is located in the United States at the University of Virginia. The UK Teacher Education home page is shown in Figure 9.

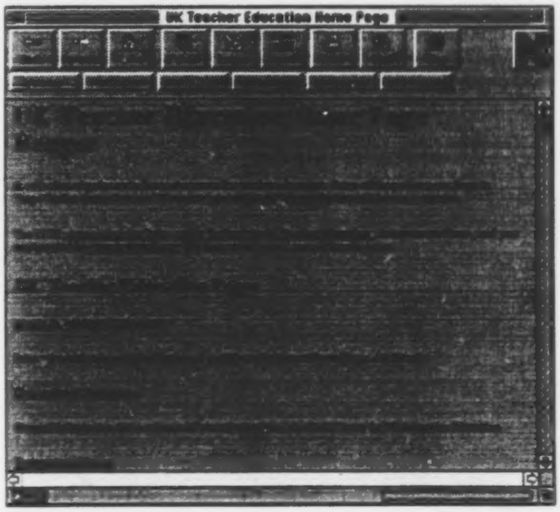


Figure 9. The UK Teacher Education Home Page

Because hypertext links can easily be embedded within Web documents, users can transparently "travel" from one Web page to the next. While we are in the early stages of developing Web pages, a WWW document related to International Education has already been developed (see Figure 10) and additional Web pages on Mathematics Education, Research, Science Education, and Educational Technology are planned.

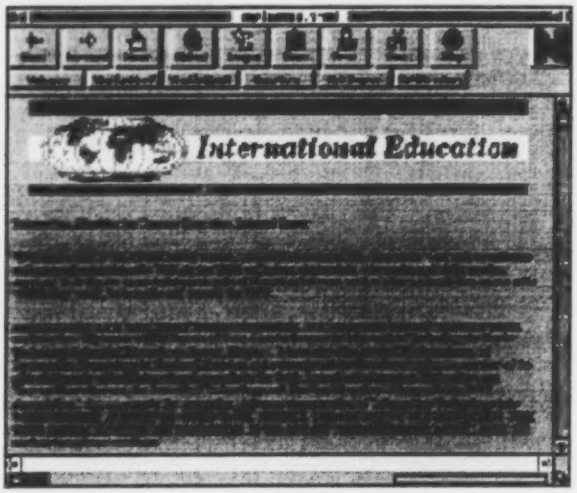


Figure 10. The International Education Home Page

It is almost a certainty that the World Wide Web will continue to grow as more institutions of higher education gain more sophisticated Internet access. As this occurs, the major portion of the Teacher Education Internet Server may become a series of World Wide Web hypertext documents which link educators around the world, with the ability to communicate and share resources more easily than ever before.

For those who are interested in participating in the further development of TEIS, or for more information, contact the authors of this paper.

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BEST COPY AVAILABLE

Special Considerations for Designing Internet Based Instruction

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What does it mean to design instruction for the Net? How is it different from other computer-based instruction? I will briefly consider some of technical considerations designers need to be aware of before attempting to use the resources of the Internet. These include network requirements, file size and transfer speed constraints, and the advantages and limitations of the various Internet programs. In the final section of this paper I will discuss briefly constructivist theory and the Internet

Aspects of the Internet and Other Distance Education Systems

The Internet has several capabilities. It can convey text, graphics, sounds, video and data. It can carry real-time interaction between numerous people and over long distances. It can reach people world wide. And the use of the Internet for instruction is relatively inexpensive. There are many programs and protocols that can be used on the Internet. These include Internet Relay Chat (IRC), which supports real-time discussion; the World Wide Web (WWW), which acts as a hypertext and multimedia interface; Usenet, which allows for asynchronous discussion and transfer of multimedia and data; Multiple User Domains (MUDs) and Multiple user, Object Oriented domains (MOOs), which are text based virtual worlds which allow for real time interaction; and e-mail, which allows for asynchronous personal communication (Kehoe, 1992). It is possible to use more than one of these programs in concert to deliver different types, or different aspects, of instruction

The Internet can deliver video, but not as quickly as videotape, television, or CD-ROM. It can carry real-time personal interaction, but not as well as telephone or video conferencing. It can display textual information, but not a simply as a book or magazine. Why then should the Internet ever be used? The Net has two real advantages over other media. It combines advantages of other media so that it conveys video and sound better than a book, is more interactive than a videotape and, unlike a CD-ROM, it can link people from around the world cheaply. The second advantage, and one that is often overlooked when discussing the Internet as a delivery system, is that it can also be a content provider. The Internet is, arguably, the largest and most diverse information resource in the world today. It is possible to incorporate the wealth of information available on the Net in your design. For instance if you are designing a module on renaissance art history, you can include links to the Vatican Library and the Louvre, as well as to the Art History exhibit of the Australian National University, just to name a few. This sort of immediate access to information and resources can not be found with any other medium.

Aspects of the Instructional Decision

Many factors must be taken into account when selecting a medium of instruction: type of content, number and location of students, time available, instructional budget, and facilities available are all factors to take into account when selecting media for your instruction. The content of instruction is often divided into different types or domains and there many authors have addressed the question of what media is appropriate for different types of content (Dick and Carry, 1990; Gentry, 1994; Reiser and Gagne, 1983; Merrill and Goodman, 1972). Although most of these suggestions were made before the rise of Internet popularity, they are helpful. For example, the World Wide Web combines interactivity with still pictures, audio, and printed text; and allows for text based evaluation. It could be used to teach *intellectual* and *verbal* skills, and to a lesser extent *affective* skills as well. If your curriculum deals with the Internet as a subject then it is the obvious, and most authentic, medium for your instruction.

Number of students and location are also important factors in media selection. If your students are few and geographically close, such as in the same building, there is little need for the connectivity and distance negating features of the Internet. But if you have many learners or they are wide spread, or both, then the Internet becomes a viable candidate. An often overlooked difficulty with Internet based instruction is the lack of enforceable security. There are no real effective ways to insure that the learner does the actual work. This is a problem if the course is for credit or certification. The simplest way around this is to require in-person testing. Of course if your students are spread from Boston to Bangkok, that may not be an option.

If time is a factor, Internet-based instruction can be set up quickly, with on-line conferences requiring only the time it takes to inform the attendees. WWW pages can be created in only slightly more time than it takes to create a similar text document, but they do require a computer for a Web server and a designer familiar with HyperText Markup Language (HTML), the language in which Web pages are written. The cost of Internet based instruction runs a spectrum from virtually free, if you use preexisting resources such as e-mail, IRC, and the Usenet; to quite costly, if you choose to run several Web pages or MUDs on a high end, well connected server and the equipment, software, and services must be purchased.

Technical Considerations

Technical considerations for Internet based instruction include computer types, network connections, data transfer rate, and program specifics. The first things you need to think about when designing your instruction is "On what computer will the instruction reside, and what sort of connection to the Net does that computer have?" For example, if you are designing a WWW based hypermedia program to teach about dinosaurs, you have to select a computer, or server, where the the actual HyperText Markup Language (HTML) documents will be kept, and decide what sort of connection to the Internet that computer is will have. The choice of computer and connection should be based upon your projected usage. With a better server (fast, plenty of memory, large hard drive) and the faster the connection more people can access the instruction. Therefore if you are designing for only a few people, who will be accessing the server one at a time, it might be acceptable to use an ordinary PC or Mac with a connection to the Internet via a 14,400 baud modem. Most people who use such a system, however, find they want a faster computer and more than one modem connection in order to transfer the graphics in a reasonable time and accommodate additional, unexpected users. A better option would be a Unix server with a fast Ethernet connection to the Internet or a T1 line (expensive but fast and reliable). With truly high end setups you can accommodate tens or even hundreds of users simultaneously and offer several programs at once.

Unfortunately, even if you have an optimal server and connection, you may still be limited in the sort of graphics and files you can present in a reasonable time because the computers your students use to access the material is also important. If your students have access only through a dial-in provider, such as America Online or the Texas Education Network (TENET), they may not be able to use a graphical WWW client, such as Mosaic or Netscape, and therefor be unable to access your carefully designed interface. Or they may have a slow SLIP connection which means it could take several second, or even minutes, to download large pictures or sounds and even longer to receive video clips. This has significant implications for course design. You can be forced to either limit your design to keep it usable by the least powerful access method available to students or you can design instruction that includes video, lots of graphics, and a graphical user interface and accept that only people with good Internet connections can use it. There is a third possibility, and it is one that is being used by many of the people currently designing Internet based instruction (GNA FAQ, 1994). You can design for multiple levels of access. It is possible to set up your system so that people who only have e-mail access, the lowest level of text-based access, can receive the text aspects of your instruction and can involve themselves in any asynchronous discussions that may also be a component. At the same time those learners with optimal access can connect over the WWW and receive the full multimedia effect. This is more difficult for the designer as it takes more careful planning, but it makes your instruction available to a wider number of learners.

Delivery Methods, Advantages, and Limitations

Common Internet delivery methods include e-mail - used for topics that can be covered using text; MOOs - used for times when real time interaction is desired; and the World Wide Web - which can provide hypermedia access to instruction. E-mail is generally thought of as one to one communication but it can also be used for asynchronous group discussions using listservs, where learners subscribe to a list and receive all of the comments from others on the list, and their responses are automatically forwarded to all the other members of the group. Even graphics files and software can be sent using e-mail, but it is slow.

Another popular method of delivering instruction on the Internet is the MOO. A MOO can be designed as a classroom, where students, who may be anywhere in the world, meet at a given time. This allows for real-time interaction with numerous students and the teacher, much like a text based teleconference. Diversity University, a virtual campus MOO where many on-line classes and meetings are held, has developed some tools which allow a teacher in a virtual classroom to control who can "talk" at any given time, as well as tools that enable the teacher to record a lecture in advance and play it back during the class, thus removing the necessity of having to type it in real time (Diversity University, 1994). MOOs are popular because they allow teacher and student to hang on to the familiar classroom paradigm.

The third common delivery method is the hypermedia of the World Wide Web. A designer can create a learning environment very similar to a more conventional multimedia computer-based training program, as delivered on CD-ROM or laserdisc. The main differences are that the Web is much slower at delivering large graphic, sound, and video files; but the content of Web-based instruction can be changed with relative ease. It is even possible to combine Web-based hypertext with media distributed to the student on a CD-ROM, thus allowing for flexible content and speedy access to media.

Size and Speed

File size and transfer speed are two of the most common limiting factors when designing multimedia Internet-based instruction. Given that most designers don't have unlimited storage capacity on their computers and that many learners are limited to a SLIP connection, it is essential that designers make careful use of media in their programs. Text is the least resource-intensive medium. An average page of text has between 1500 and 2500 characters on it. This translates to approximately 2500 bytes (2.5 kilobytes) of stored computer data. Compare this to a single full screen graphic which can take 50,000 to 500,000 bytes. And videos are even larger. A ten second, half screen Quicktime movie can take up to 5 million bytes (5 megabytes). Compare this to some average transfer times. A 14,400 baud modem, with a good connection transfer an average of 1000 bytes per second. A good Ethernet connection will average ten times that speed, or 10,000 bytes per second. Thus with a home computer and modem it only takes seconds to transfer text documents, but it can take up to an hour and a half to transfer one short video clip. On Ethernet it is significantly faster, with a 5 megabyte video clip taking only ten minutes. But this is still a long time to wait for a very short clip. What these time constraints mean is that unless a video is essential to instruction, leave it out. If longer video clips, or more of them, are needed, you might consider using video tape or CD-ROM as your delivery medium, perhaps in conjunction with your Internet-based program.

Theoretical Considerations

Thus far I have discussed considerations of when and how to use the Internet for instructional delivery from a fairly objectivist point of view, but the Internet could easily be considered the ultimate constructivist learning environment. Consider, for example, Cognitive Flexibility Theory (Spiro and Jehng, 1990). Cognitive Flexibility Theory deals with "the special requirements for attaining advanced learning goals, given the impediments associated with ill-structured features of knowledge domains" (Spiro, Feltovich, Jacobson, and Coulson, 1991) and suggests a metaphor "of the criss-crossed landscape with its suggestion of a nonlinear and multidimensional traversal of a complex subject matter" (Spiro et al., 1991). This desire for multiple perspectives and knowledge criss-crossing could be well supported in the Internet environment, especially using the hypermedia of the World Wide Web in conjunction with one of the Net's discussion facilities.

> "We have referred to the need for rearranged instructional sequences, for multiple dimensions of knowledge representation, for multiple interconnections across knowledge components, and so on. Features like these correspond nicely to well known properties of hypertext systems, which facilitate ... multiple linkages among content elements" (Spiro et al., 1991, p.67).

The Internet can and does provide all of these elements, including presenting content from various perspectives.

For instance, consider the case of the renaissance art history course mentioned earlier. Art history certainly falls under the heading of *ill-structured domain*. Using the random access instruction strategy discussed by Spiro you might set up your Web page with links to numerous art repositories, links to expert interpretations (preferably conflicting ones) of each piece, links to an art history discussion group, links to other related information, and cross links that take the learner through the same information several times and from several directions. This would allow the learner to explore multiple routes through the same content thereby reinforcing cognitive construction. Evaluation, if required, could take place in the discussion groups, or by communication between learner and evaluator via e-mail.

Summary

The Internet is an appropriate delivery medium for instruction when the instruction is designed for many learners, separated geographically and the subject is one that can be conveyed through text and graphics, on-line interaction, and limited audio and video. In some ways the Internet is best suited for ill-structured intellectual and cognitive domains, taking advantage of Spiro's random access instruction hypertextual strategy.

Technical considerations that must be considered by designers include include the effect of computer and network connection, both for the instructional provider and the learner, and the limitations of file size and transfer time. Text, graphics, and small audio clips can be used effectively over the Internet, while with current technology video can be prohibitively large. As the Internet is just emerging as a viable instructional technology, there is still a great deal of research that needs to be done, exploring the best uses of that technology. Luckily the basic structure of the Internet encourages exploration.

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[All references are correct as of April 25, 1994. Internet based references are subject to change without notice. WWW=World Wide Web, FTP=File Transfer Protocol]

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A Tutorial Simulation to Introduce Teacher Education Students to USENET

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Recently, the use of computers as communication tools has grown rapidly in K-12 and higher education. Through computer networks students and teachers can obtain public domain software, communicate with experts, and participate in a wide range of collaborative projects beyond the walls of their classroom.

There are many resources on the Internet that would be useful to teachers. However, if teachers are to use them they must be aware of the resources and understand how they can be accessed. This paper describes the creation of a tutorial simulation for use in preservice teacher education programs that introduces one aspect of the Internet, the USENET collection of worldwide special interest newsgroups.

Overview of USENET

In 1979, Tom Truscott and James Ellis at Duke University developed the *Netnews* software and made USENET possible. USENET began with just two sites: Duke University and the University of North Carolina. Because USENET is a faster and more flexible means of sharing ideas and information, it has become one of the most used resources on the Internet. Today there are over 5000 different special interest groups in the USENET system. In many ways USENET is probably best considered a logical network that has no central authority.

USENET is not actually a part of the Internet, but it uses the Internet to propagate itself. USENET is made up of all the machines that receive network news (Tolhurst, Pike and Blanton, 1994). There are more than 5,000 newsgroups, although not all newsgroups are available on every system. The purpose of USENET is to help users communicate effectively with others who have similar interests, to facilitate scholarly collaboration, and to share ideas, materials, or strategies. This resource is available, however, only to teachers who know how to use it. Despite the advantages of resources like USENET, use of such resources by teachers is not yet commonplace. Teachers need to learn how to use computer-mediated communication services.

Description of the Software

The software developed is a combination tutorial and simulation. It covers the basic concepts of telecommunications to establish a foundation, and guides the learner through a computer simulation of using USENET newsgroups. The tutorial program consists of three main topics:

1. What is USENET,
2. Understanding USENET News, and
3. How to Use USENET.

Students can select any of these options from the initial menu and begin a training session on the topic. The *How to Use USENET* session includes seven subsessions with interactive instructions: a) initializing the news reading program, b) selecting newsgroups, c) reading articles, d) posting an article, e) responding to an article, f) saving articles, and g) exiting from the news reading program.

MORE INFO
ON CD-ROM

To develop the software, the author used a variation of the the Four D instructional development model of Thiagarajan, Semmel, and Semmel (1974) that has four stages: Define, Design, Develop, and Disseminate. Although the original model is typical of behaviorally-based, linear development models, the variation used in this study is not. The model was modified by Dr. Jerry Willis at the University of Houston to include recursion. Instead of proceeding in a linear way through each of the four stages, design and development moved back and forth through these four stages several times so that the design and form of the program gradually emerged from the interaction between the developer, expert evaluators, and students.

The Definition Stage

The purpose of this stage was to define the need of instructional material. This stage included the following steps: (a) front-end analysis that examined the need for the instructional material and any existing materials, (b) learner analysis that identified characteristics of target trainees relevant to instructional development, (c) task/concept analysis that described the components of the task or concept to be taught, and (d) the creation of instructional objectives that defined the outcomes expected in instructional development.

Front-end Analysis. There are some print materials for guidelines on telecommunications. *The Whole Internet* (Krol, 1992), *Managing UUCP and Usenet* (O'Reilly and Todino, 1988), and *The Waite Group's UNIX Communications* (Anderson, Costales, and Henderson, 1991) are detailed technical guides; *The Internet Companion* (Laquey, 1993), and *Zen and the Art of the Internet* (Kehoe, 1993) are beginner level background readings on the Internet. Even "beginner" material, however, is difficult for novices who do not have strong personal computing backgrounds. Some focus mainly on technical aspects of the Internet, and others tend to mention basic concepts without providing guidelines about accessing resources. Much of the available material is more *about* telecommunication than *how to* telecommunicate.

The tutorial simulation program developed focuses on the *fundamental concepts* of USENET and *how to* use USENET. The examples and illustrations used in the program are relevant to teachers, and the reasons given for using different USENET resources are all educationally relevant rather than relating to other topics such as advanced hardware information or computer science.

Learner Analysis. The purpose of this stage was to identify characteristics of the target users which are relevant to the design of materials. Despite various reasons for computer technology in the classroom, most teachers are not using computer technology in their teaching. However, most teachers want to use technology in their teaching (Fulton, 1989). One reason for the gap between interest and ability may be inappropriate training materials that do not meet the needs of teachers.

In this study, the target users were undergraduate and graduate students enrolled in an introductory educational computing course in the University of Houston's College of Education. The students in this course came to class with a wide range of backgrounds - some had never used a computer while others were very experienced. Therefore, the software needed to provide substantial support for novices (e.g. hypertext buttons that explain terms) but in ways that do not require the experienced student to read through material they already know. Because of this , much of the basic information in the tutorial is available on request but is not presented automatically.

Task Analysis. The main reasons for developing this instructional material were to help students develop a basic understanding of telecommunications, especially USENET, and to help them develop a basic facility with routine USENET operations. The task of using USENET was broken down into the seven elementary subtasks: initializing the news-reading program, selecting newsgroups, reading articles, posting an article, replying to an article, saving articles, and exiting from the newsreading program.

Specifying Instructional Objectives. Four objectives were: a) The students will initialize the news-reading program, b) The students will select newsgroups in their area of interest and subscribe to them, c) The students will participate in newsgroups through reading, posting, or responding, and d) The students will store selected articles in files.

The Design Stage

The design stage of the instructional development cycle has three phases: media selection, format selection, and development environment selection.

Media Selection. As might be expected, the medium of instruction selected was computer-based instruction. This choice seems especially appropriate for computer-related topics. Students at the University of Houston may, in fact, complete the training program on the same computer they later used to actually connect to the Internet.

Format Selection. Lee (1994) emphasized the importance of "learning-by-doing" in programs that prepare teachers to use telecommunications resources. With that in mind the software developed used a combination of short interactive tutorials to cover basic information, and simulated USENET activities to teach basic "how to" skills.The program combined text, graphics, color, and sounds to motivate and to help novice learners master USENET. It consisted of two parts: a tutorial mode and a simulation mode. The first part covered fundamental concepts about USENET in a non-linear format that accommodates learners with a wide range of backgrounds. The second part provided opportunities for hands-on experience with guided instruction (support and advice when problems develop as well as examples that illustrate how to accomplish a particular task).

Although there is considerable debate about the amount of learner control (versus program control) that should be built into instructional software, this program gave learns control over a number of factors including sequence, exposure to optional content, and the amount of practice. Using the program, the learner can select what information to explore, in what order, and at what speed. Therefore, higher achievers or those with more experience can move more quickly through the information, while novices learners can repeat any sequence of instruction or practice and ask for help with terms and procedures.

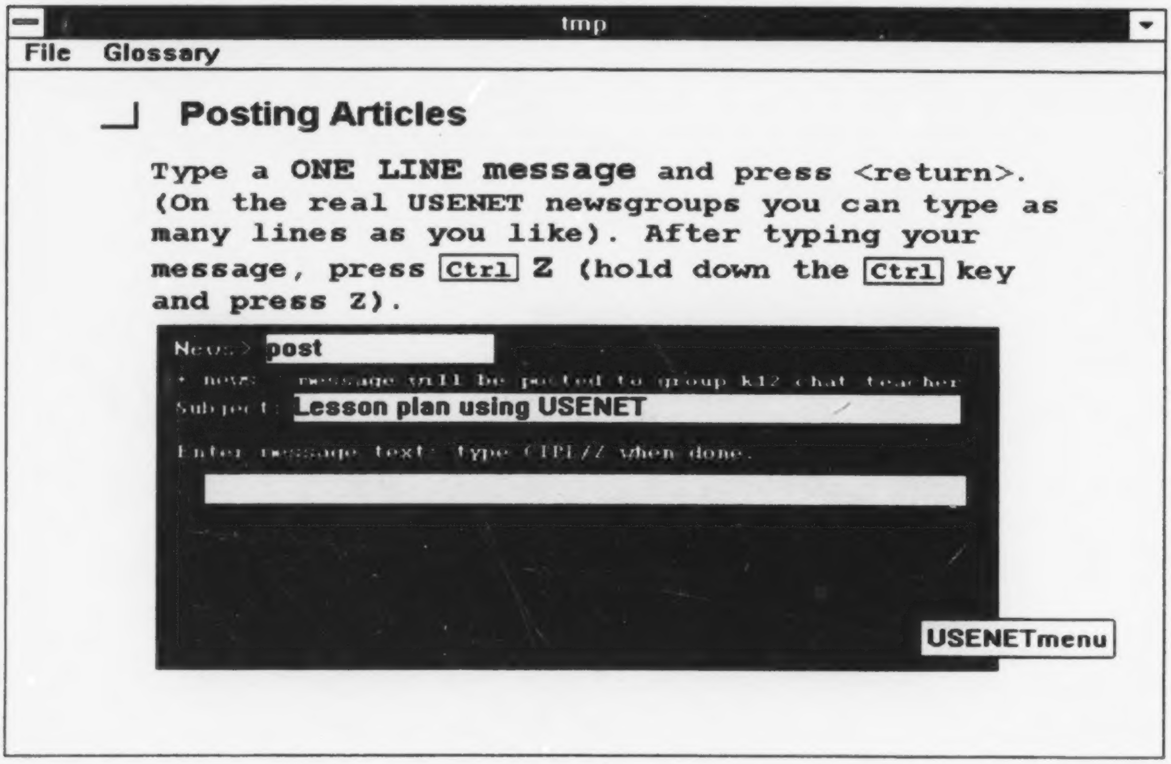
One of the problematic decisions that had to be made in the early stages of development concerned which news reader to use as the prototype in the simulation activities. There are many news-reading programs that allow users to read what others have written, respond publicly or privately to the article's author, and post new ideas, questions, requests, or information. On UNIX systems, some of the most popular programs are *rn*, *nn*, and *trn*. On the other hand, the academic computing staff at the University of Houston supports two USENET news readers under the VMS operating system: *vnews* and *newsrdr*. Even though each news-reading program provides different commands and screen appearance to the user, all can access the same newsgroups. The instructional software used used the *newsrdr* program as the prototypical reader because it is friendlier than *vnews* and easier for novice users.

Development Environment. The tutorial/simulation was developed in the *Authorware Professional for Windows* (APW) authoring system. APW offers protocols for creating computer-based instruction, and is a relatively easy to learn but powerful system for creating interactive multimedia instruction.

The Development Stage

In this stage prototypes of the various components of the tutorial simulation were developed. The prototypes were evaluated in two ways: by experts and by students from the target groups. The program thus had undergone a recursive process of development with tryouts and the feedback from experts in the fields of telecommunications, instructional technology, and educational telecomputing. Through the recursive developmental process an effective instructional package was produced.

Expert Evaluation of the Program. Experts who evaluated early prototypes pointed out that the author needed to provide a full explanation of what students wer to input and why, at least for the first few times it is required (see Figure 1). Experts also thought consistency of screen layout and arrangement as well as clear, concise directions were very important for creating good instructional material. Therefore, the revised program maintains consistency in the various items such as buttons, heading text, guidance, color, background, screen density, terminology, or writing style (font size or style; bolding, italics, and color).



Posting Articles

Type a ONE LINE message and press <return>. (On the real USENET newsgroups you can type as many lines as you like). After typing your message, press Ctrl Z (hold down the Ctrl key and press Z).

```
News> post
* news:  message will be posted to group k12.chat.teacher
Subject: Lesson plan using USENET
Enter message text; type CTRL/Z when done.
```

Figure1. The meaning of "Ctrl Z" was explained here.

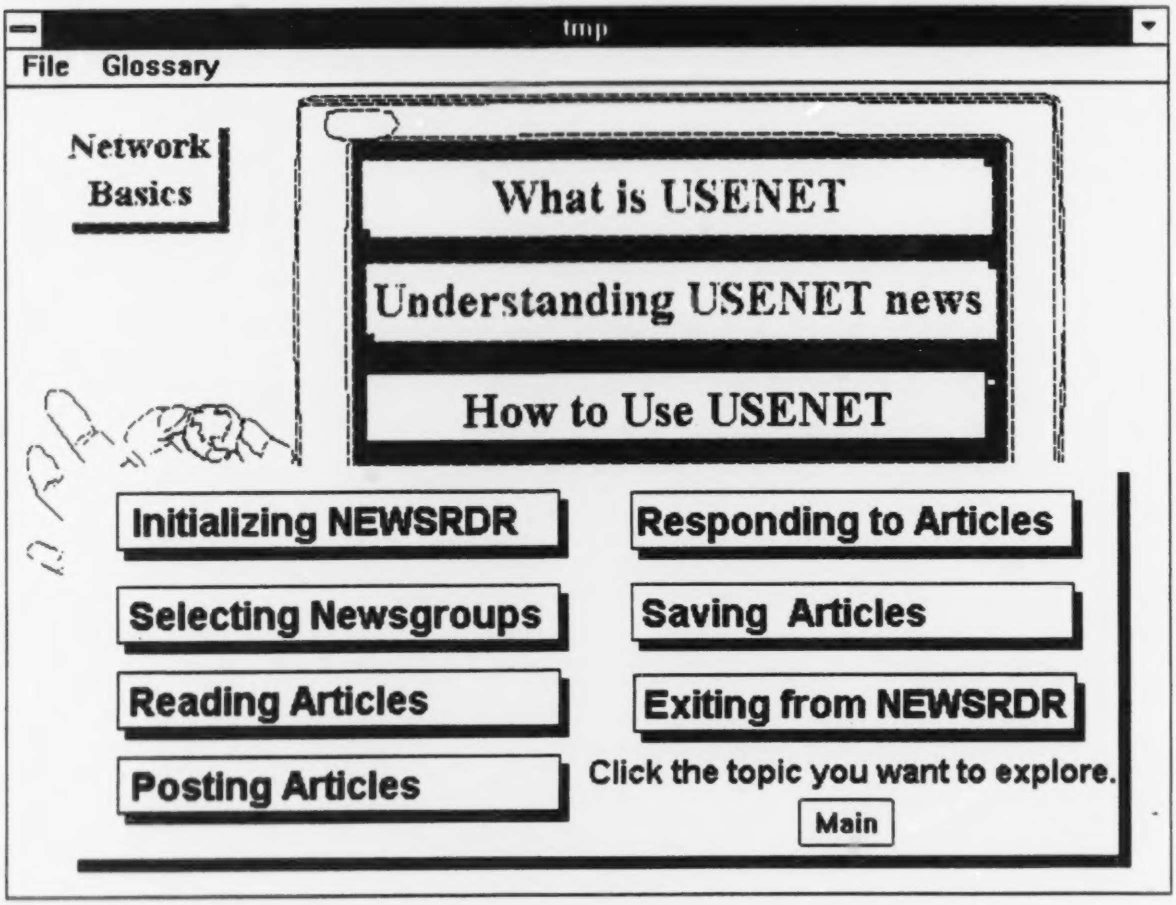
Other comments from the experts included suggestions that the program include information about other Internet services, that some areas needed more examples or more information to clearly make the desired points, and that some of the explanatory material be rewritten to make it appropriate for novice users. Revisions included all three of these suggestions. One section of the software includes some information on other Internet services such as Telnet, e-mail, FTP, and Gopher, but the primary instructional focus remained on USENET. (An expansion of the software may include instructional material on these other services as well.)

Feedback From Tryouts With Students. At several points in the development process, students used prototypes of the software and gave detailed feedback to the developer. Early in the process one group, five students enrolled in an introductory educational computing course, observed the program with guidance given to them orally by the author. Although most of them were unfamiliar with USENET newsgroups, they were positive about the rough prototype and wanted to see a complete version to learn more about USENET. Feedback from the students in the first tryout can be summarized as follows:

Positive Feedback. a) interesting and useful content for the students and teachers, b) very effective graphics to help explain the subject, c) good user-control over the pace, d) option buttons for exploring a topic or cruising through the program are useful, and e) concise and clear explanations.

Negative Feedback. a) needs more consistency in the directions, b) needs an appropriate target area to show where to click rather than just clicking on the whole the screen, and c) needs a description of the topics to be covered in the program at the beginning.

After considerable revision a second formative evaluation was conducted with two groups of students enrolled in an introductory educational computing course. A group of seven students was given guidance orally by the author. A student in the group operated the program and every member in the group was asked to turn in feedback including comments about difficulties while using of the program,



Click the topic you want to explore.

Figure 2. The opening screen.

and the effectiveness of the program. Half of them had minimal experience on Internet services such as e-mail or Gopher and the rest had no experience at all. Many questions were raised by the group, and most students wanted to use the program individually when the program was completed. The questions were about how to access USENET from their home, differences between USENET and Internet, how to connect with a server, and so on.

The other group, six graduate students enrolled in an introductory educational computing course, was not given guidance while using the program. They finished the program in a short time because they did not select many optional buttons. Feedback on the program from these two groups was similar to the evaluation of the prototype version.

A Description of the Final Version of the Software

The program provides one main menu with three topics and a pop-up submenu at the bottom of the screen that consists of seven subtopics (see Figure 2). The sequence of instruction was changed several times based on expert feedback and formative evaluation from the students. The program includes the following main topics: *What is USENET*, *Understanding USENET News*, and *How to Use USENET*, and a supplemental topic about fundamental network concepts for novice users.

The *What is USENET* session includes a definition of USENET, the history of USENET, brief descriptions of several major categories and alternative categories in the newsgroups, and other services available on the Internet such as e-mail, telnet, anonymous FTP, and Gopher.

The *Understanding USENET News* session covers subtopics about what can be found on USENET, the difference and relation between USENET and Internet, the format of news articles, and USENET acronyms. The *How to Use USENET* session provides detailed instructions on using USENET. This session provides interactive instruction with step-by-step guidance to introduce the basic commands needed for participating in USENET newsgroups. It is divided into seven small subsessions and each subsession has a specific objective. Every subsession has a consistent screen format and instructional sequence that includes guided instruction and simulated USENET activities. The learner may go to the next screen after a correct response, or attempt to respond again after error messages or feedback following every incorrect response.

Conclusions

There were two types of objectives for the program: to make students aware of the ways USENET newsgroups might be used, and to provide basic information on how USENET can be accessed and used. Within the simulated USENET environment, students had available to them step-by-step guidance. As they practiced various aspects of USENET operation, the program checked the accuracy of their commands and provided feedback as well as additional opportunities where needed.

The program was developed through a recursive process of development, feedback, and revision. This structured but recursive approach to designing software seems to work well for this type of software development project. The changes that resulted from the feedfback provided by tryouts and expert assessment involved both the interface and the actual content taught, as well as the sequence of instruction. The final product, in the opinion of both experts and potential student users, is a program that facilitates learner exploration of USENET.

This software can be stored on a single high density floppy disk. It will run on virtually any computer running Windows 3.1 or higher, but performs best on faster 386, 486, or Pentium systems. In use, the program might be an out-of-class or homework assignment for students before they try to log on and search for information in USENET newsgroups. It could also be used as an in-class activity with individuals or small groups of students working through the tutorial information and the simulated USENET activities. Since the program does not require the user to be connected to a network or telecommunications system to practice, it may be especially useful when the goal is to teach many students to use USENET, but only a few connections are available.

The students who evaluated the program preferred it to conventional instruction such as lectures or text-based instruction. They liked the ability to control the pace of instruction and the opportunities to select content to study. Clear directions and the availability of help and feedback were also viewed very positively. Although students liked the ability to choose the content they would study, one problem that emerged from the formative evaluations was related to student choice. Some students could follow every instruction easily, but they had only a fragmentary understanding of the operation of USENET. That seemed to be related to lack of basic knowledge about telecommunications or to skipping optional information, which the student actually needed, when working with the program in small groups. Optional, in this study, meant information some students might already know. To solve this problem, future editions of the software may reduce the optional information or add a requirement that students "pass a test" of some type over the information before bypassing it.

To summarize, this software development project illustrates the successful use of a structured, recursive approach to instructional design. The result is a usable program that is a good fit with the target environment - an introductory course on educational computing. It is, however, only one aspect of a comprehensive package of support material that is needed to help preservice teachers learn about and learn how to use computer-mediated communications services. For information on acquiring the software for classroom use please contact the author or check the CD-ROM version of the Annual.

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Multimedia Telecommunications: services for professional development.

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MORE INFO
ON CD-ROM

Emerging communications technologies enable specialist expertise and resources to be delivered from a distance and thus increase the range and quality of teaching and research available within an institution. The consequences of this are likely to have a profound effect upon all teaching and learning in the near future. A developing role for educators in the university sector is in the provision of services via the "Information Superhighway."

To harness the power of burgeoning communications in a way that will provide an effective service to education, systematic piloting and evaluation of the learning experiences must be carried out. This paper describes services under development in the University of Exeter in the UK. Two main projects are involved in this. The Multimedia Communications Brokerage (MCB) is funded by the Department for Employment to create services and test the concept of a brokerage. The New Technologies Initiative project, funded by Joint Information Systems Committee, will test the feasibility of remote team teaching between universities over SuperJANET, an enhanced version of the Joint Academic Network (JANET). The production of multimedia resources requires a range of skills and knowledge not often found within one institution. Partnerships between two universities can benefit the teaching and research of both institutions complimenting the skills and expertise across sites to the benefit of two cohorts of students.

Multimedia communications can provide:

1. curriculum development and specialist teaching
2. professional development for senior staff
3. mediated review of new software and multimedia products
4. access to a consultant

At the same time the projects are developing information and advice on the adoption of multimedia communications themselves. Information is being published on the adoption and integration of appropriate multimedia technology to match the user's needs. A complimentary distributed network of informed, experienced and active practitioners in the educational multimedia field is also evolving in the UK.

The Brokerage

ISDN lines support high speed telecommunications services. Some of the first applications of ISDN in education were described in Davis (1992). At that time the focus was on integrating remote teaching, including student teaching, into the curriculum of secondary schools. A cost benefit analysis showed that the schools most valued the professional development for a wide range of staff: support staff, teachers and senior managers. However, it proved difficult to provide a wide range of activities for the schools. The limitation was the range of expertise within one university which matched the needs of the schools. The concept of a *brokerage* was born of this realization. There was a need for both new services and new clients, and a *brokerage* could build and support new partnerships. The brokerage stimulates the market and provides support for the development of new services, and service providers. The service providers also enlarge the market by advising their clients of the services and new modes of professional development available using multimedia communications.

The work reported here retains the high quality sound and images possible using DeskTop Computer Conferencing (DTC), rather than the more common video conferencing. DTC transmits audio as well as computer graphics and video. However, the maximum transmission speed of high resolution images currently is one per second and so the project is focusing on still rather than moving images.

The Services

The following section describes some of the services under development.

An Educational Guide to the Internet

Increasing access to the international electronic communications networks ("the Internet") offers many possibilities to schools. In the UK educational use of the Internet has been largely restricted to Universities. Potential access is increasing with new services. The installation of Cable TV networks is increasing free local call access. [Editor's Note: In the UK there is a charge per minute for every call made in contrast to "free" local calls in the USA.] Large volumes of information are available in three main forms: bibliographic searching, text and multimedia collections, discussion groups. Such access is revolutionary because the end-user has efficiently been moved from a dependence on locally based resources such as print materials in libraries. Electronic resources on the Internet are available world-wide. This is vitally important in supporting research, and hence facilitating the concept of research supporting teaching. In the UK early use of services such as the *Bulletin Board for Libraries* (BUBL) *and National Information Services and Systems* (NISS) made access very simple. Gopher and World Wide Webb are now also widely used.

In addition to an overview of the vast sea of files available across the world, the School of Education librarian's Internet service demonstrates Exeter's WWW server which provides local information. Recent funding has been set aside for production of resources designed for remote use by University of Exeter students on school-based programs. Discussion groups also abound. Local news groups are being developed in conjunction with electronic mail to support communications between student teachers and their tutors and to run remote seminar discussions.

Cell Biology and Electron Micrograph Interpretation for Biology

Visual images are fundamentally important in the study of biology. Students' understanding of biological processes requires observation and interpretation of suboptical structures and their related functions. Transmission electron microscopes (TEM) can resolve images about 200 times better than the best light microscopes because they use the far shorter wavelength of an electron beam focused through the specimen by electromagnets. Images such as these require a very high degree of expertise to capture and to interpret, but they are very important in the study of biology from the secondary level upwards. A mediation service was therefore developed.

DeskTop Computer (DTC) conferencing between advanced school biology students and a university tutor with expertise in electron microscopy provides a service of intensive tutorials using first hand micrographic material with guided interpretation. The DTC software permits students to interact with the image, under the clear guiding voice of the university tutor. This both facilitats understanding and provids access to fresh, high quality resources.

The aim of the service is twofold:

1. To provide an introduction to the interpretation of electron micrographs.
2. To provide further support for students' understanding of cell ultrastructure and physiology, using the reproductive system as illustration.

The reproductive revolution is rarely out of the headlines. The attempts of the scientific community to control human fertility and to alleviate human infertility are seen as among the most important endeavors of late twentieth century biomedical research. Recent enlightenment has come about as a result of an increase in our understanding of the structure and function of the gametes (sperm and eggs) and their supporting tissues at the cellular and molecular levels. More basically, the significance of reproduction as the single most distinguishing characteristic of life is reflected in the relative importance placed upon it in school biology syllabuses.

High quality electron micrographs of gametes and reproductive tissues were transferred onto PhotoCD, and image management software has been used to display and manipulate these images during the conferencing link between schools and the university. The relevant sections of the school syllabus were enhanced using these materials. Students were given a follow-up exercise to test their understanding of the subject matter, and they were also invited to give their comments about the learning experience. This data is now being analyzed. Further detail are provided in Baggott and Wright (submitted).

Basic Concepts in Geology

Geology in the secondary school curriculum has been problematic for over a century in the UK, mainly because of its overlap in the differing curricular areas of Geography and Science. One consequence of this is that knowledge and understanding of basic geological concepts is not widely spread within society at large, and this includes teachers and hence pupils in schools. For example, the most fundamental concept, that of geological time is poorly understood generally. This service provides a direct learning experience for 14 to 16 year old pupils through expert teaching using images in a DTC link with pupils in schools.

The service was developed as a sequence of 1-hour sessions for 14 year olds on basic geological concepts. The service used images drawn from a large image database. The topic, *local rocks*, involved the generation of an in-depth discussion with school students about the origin of the rocks and more significantly, possible time scales involved.

The learning activity was centered on the cyclic process of observation, description (articulation), questioning, and selection (i.e. of additional images relevant to the question). The ideas of "deep time" and palaeogeography were introduced in this session, and pupils were encouraged to hypothesize about geological phenomena. Subsequent sessions dealt in a similar way with increasingly complex ideas, but within the definition of "basic geology" in the British National Curriculum.

The DTC teaching was supported by giving students access to geological specimens, which were sent on to the school in advance (as files transmitted over the telecommunications line). The images used in the service included color pictures of rock exposures, general landscapes, building materials and individual specimens, such as fossils. Diagrams and sketches were also employed, and, because the images and illustrations were in electronic form, students could annotate and modify images on the screen. These features make this an adaptable and flexible learning mode, which can easily be made relevant to a range of abilities, experiences and locations of students.

CD ROM Evaluation Service

One fundamental problem when purchasing educational materials that cannot be first obtained on an approval basis is assessing the quality and suitability of potential purchases. This is particularly true in the case of CD-ROMs. Because the profit margins are so small, companies do not find it economical to send a representative or salesman to remote locations to demonstrate the materials. However, educational CD-ROMS are relatively inexpensive and many schools annually purchase additional CD-ROMs for classroom and library use. One way round the demonstration problem is to offer an evaluation service through DTC. A piece of peripheral hardware enabling this is a quad-speed CD-ROM jukebox (Pioneer 604X) which gives very good representation of the multimedia resources. The customer phones through on the ISDN line to inspect the goods. An advisory discussion can lead to an interactive demonstration of the CD-ROMs which interest the buyer, who can then be handed the keyboard and left to "play". Questions can be answered, thereby helping the customer to make an informed decision. Costing for the advice and prevention of piracy are issues currently under consideration before the evaluation service is launched commercially.

Multimedia Staff Development

Team teaching and remote staff development on topics related to multimedia resources is another example of the appropriate *utilization* of University expertise. Initial training days *in situ* may be followed up by on-line sessions working with small groups or individuals who are developing their own use of IT. Success of this 'service' is more dependent upon commitment from the institution in terms of resources required. For example, providing resources to free members of staff to work on the project. However, it is hoped that as the potential for producing high quality teaching materials precisely suited to requirements are realized, this service will become increasingly popular.

Conclusions

The world of education is being transformed by the development of communications networks which offer users at remote locations access to learning materials held on a central computer. These services are made available through broad band communications. Point-to-point services can be developed to address the needs of small groups and individuals in education. The *brokerage* concept can extend these services across new service providers and their client groups. The initiative, based at the University of Exeter, has encompassed the world of both education and business, with educational participants providing expertise in an expanding range of subjects.

Multimedia communications has enormous potential for enriching and extending current educational practices within higher education itself, but it has yet to make its full impact on the majority of courses and students. A knowledge base within this field does exist, but different components are located within key individuals at a variety of institutions. The scattered location of leading edge knowledge and practical expertise can be partially overcome by the adoption of new communications technologies. The "Information Superhighway" in itself however provides no more than a means of communication to remote sources of information which can add to an academic's current overload. On-line partnerships can share and expand the expertise available.

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RESEARCH

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The papers in this year's Research section generally address one of three questions: "What are the attitudes of X toward Y?", "What was the effect of A on B?", or "The current status of C is."

Studies of effect include several on preservice teachers. Reed and colleagues at West Virginia University report a ten year analysis of teacher education student characteristics including technology usage patterns and anxiety levels. Another long-range study was completed by Topp, Grandgenett, and Mortenson on the statewide impact of Nebraska's efforts to provide teachers with Internet access. Manus and Denton at Texas A&M focused on the effects of staff development on teachers in professional development schools, and Waxman and Huang looked at the impact of technology use in middle school mathematics classrooms. And, while she does not any effect research, Capper reviews the literature on the use of interactive videodiscs for training.

Studies of attitudes and opinions addressed a range of questions. Fleener looked at factors related to beliefs about calculator use in a sample of preservice elementary teachers in a math methods course. Dubois, Linek, Gentsch, and McEneaney assessed the attitudes of field-based teacher education students to technology integration, and Lyons and Carlson as well as Kraus and Kraus looked at the attitudes of teacher education faculty. Jinkerson, on the other hand, asked school administrators what types of skills and knowledge students should acquire in their teacher education programs while McKenize and Clay asked similar questions in their assessment of an instructional technology course. Huang, Waxman, and Padron also studied the attitudes and abilities of students in an educational computing course

Several studies surveyed the current status of technology related issues. The Zimmermans, for example, surveyed state technology curricula while Strudler, Quinn, McKinney, and Jones asked teachers in their first year of teaching about their technology practices and the barriers they felt limited use of technology. Four papers report aspects of the surveys and case studies of teacher education faculty, innovative programs, and recent graduates that were commissioned by the Office of Technology Assessment.

A final type of paper in the research section addresses the question of how something should be done. One paper falls into this category. Tellep and Tellep offer suggestions on how to implement a systems approach to change.

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Computers and Teacher Education Students: A Ten-Year Analysis

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This paper centers on 10 years of collecting the following computer-related data about teacher education students at West Virginia University: Major, Prior Computer Use, Gender, and Computer Anxiety. The purpose of this paper is to discuss the effects of major, prior computer use, and gender on computer anxiety as well as patterns in the types of prior computer use with which teacher education students enter the teacher education program and how these use-types have changed over a 10-year period.

Technology and Elementary School Use

The Princeton Survey Research Associates (1993) group conducted a national telephone survey of 1,206 regular education teachers and found that, in the elementary school grades, computers tended to be distributed in individual classrooms; whereas at the secondary level, computers were more likely to be concentrated in laboratories. Two-thirds of the teachers in elementary schools had at least one computer in their classroom. However, classrooms with more than one or two computers were more common in the higher grades. Wilson, Hamilton, Teslow, and Cyr (1993) found that teachers overwhelmingly preferred four to six computers in the classroom over computer labs.

Yopp (1993) reported that in 1991, 31 percent of elementary education majors at SUNY College in Buffalo, had never used a microcomputer in any college course. These students ranked learning to use a microcomputer more effectively as either "a top priority" or "very important." If new teachers are to use technology effectively with their students, they must have appropriate experiences and instruction (Thompson, Schmidt & Topp, 1993).

Technology and Secondary School Use

Henderson and Landesman (1989) reported on the development of a series of video disc modules for precalculus instruction and found the use of them to be as effective as regular classroom instruction. In another study, Savenye and Strand (1989) described the development of an interactive-video-based curriculum in high school chemistry. Based on data from nearly 2,300 students and 26 teachers, students exposed to the interactive video curriculum achieved generally higher chemistry scores than did those in the traditional curriculum, with greater differences found in students of lower ability. Teachers reported that their students were learning more and that they preferred learning via the electronic curriculum.

Nelson and Palumbo (1992) have found that early implementations of Hypermedia-Assisted Instruction (HAI) in education have concentrated on the medium's capabilities in presenting information, with little attention paid to the learning process. A more recent study by Reed and Rosenbluth (in press) explicitly targeted high school students' knowledge construction. They found significant increases in both the amount of historical knowledge learned and in their awareness of the interrelatedness of historical factors.

Students' Attitudes toward Technology

In an extensive meta-analysis of 20 years of prior research involving students from grades six through 12, Kulik, Bangert, and Williams (1983) found that students who had been taught using computer-based instruction (CBI) developed positive attitudes toward the computer as well as CBI. Computer instruction was also found to reduce the time students needed for learning. They reported that the strongest effects of CBI occurred in studies having the shortest durations.

In a longitudinal study of students in grades four through 10, Krendl and Broihier (1991) found that students' attitudes toward CBI may have been inflated initially by the effect of novelty. Specifically, the authors found that students' preferences for computer-based activities and their assessments of perceived learning via the computer both declined significantly over three years. Students' perceptions of difficulty of computer use showed no decline. These findings seem to run counter to those from studies of shorter duration.

Palumbo and Reed (1991) studied the effect of two types of computer instruction (a computer literacy course and a course on the BASIC programming language) on the computer anxiety and problem solving skills of high school students. Both courses were found to produce significant decreases in computer anxiety. No significant difference in changes in anxiety was found between the two types of computer instruction.

Technology and Gender

Researchers of gender differences in computer-related behaviors have reported a confusing picture (Kay, 1992). There is much research suggesting differences between males and females in performance (Felter, 1985), attitudes (Bruner, 1990), and equality of access (Nelson & Watson, 1991). In these studies males spent more time with computers, showed more confidence and more interest, and tended to crowd out females for access to computers. However, other research exists which show no gender differences in computer-related activities (Jones & Wall, 1985). Nelson and Watson claim that the discrepancies that exist between males and females result in an inequitable chance for females to acquire the same technological skill levels as males.

In their analysis of gender differences in teachers as role models in microcomputer-based mathematics and science instruction, Stasz, Shavelson, and Stasz (1985) found that both female and male teachers provide leadership in the use of computers. It may be that teachers in technically oriented subject areas such as mathematics and science are more likely to adopt computer-based instruction.

Technology and Teacher Education

Apart from limitations on funding for hardware and software, researchers have identified certain teacher-related variables which have served to limit the full integration of computer technology in secondary school curricula. Such factors include the origin of computer-based instruction in mathematics and computer science classes, resulting in the segregation of computer-using teachers from non-users; and inadequate in-service training, resulting in teachers' fears that their students were more competent than they in computer use (Nelson & Watson, 1991). Lack of computer experience has been identified as a factor in teachers' negative attitudes toward computer-based instruction (Loyd & Gressard, 1986).

Research has shown that it takes a rare breed of teacher to implement technology into the classroom. Some hindrances related to technology integration include: teachers' lacking time to develop computerized lessons, too few computers per student, not enough time in school schedules for computer-based instruction, and lack of financial support (Sheingold & Hadley, 1990). Those able to overcome some of these hindrances included teachers who had had prior experience with computing (Hunt & Bohlin, 1991). Teachers' negative attitudes toward computing in education, for the most part, seems to be due to lack of knowledge and experience in this area (Summers, 1990). Drazdowski (1993) has noted that the training teachers received in preservice computer education was considered "too narrow and technical." They thought that "learning how to teach with computers" would be more beneficial than "learning about computers."

Researchers have found that attempts at technology implementation that failed to incorporate affective components were doomed to failure. Hunt and Bohlin (1991) saw that there were factors besides the technical ones and proposed making the affective issues an identifiable part of the training of teachers, not an afterthought. Carey (1992) suggested taking into account user characteristics, such as attitude, previous experience, and anxiety.

Ruopp, Pfister, Drayton, and Gal (1993) implemented "LabNet" via electronic mail to provide a medium for professional discourse. LabNet and similar enterprises have been found to foster a sense of community among educators as an antidote to professional or geographical isolation.

Knowledge was found to have positive relationships on teacher attitudes toward technology (Lillard, 1985). Carey (1992) noted that even after one computer course, teachers' attitudes were positively influenced. Ernest and Lightfoot (1986) and Overbaugh and Reed (in press) found that as post-assessment anxiety levels decreased, teacher attitudes toward computing improved. Most teachers are convinced of the worth and usefulness of technology in education. Most see it as a valuable tool in the classroom, one that can increase student motivation, interest, and satisfaction (Wilson, 1993). Additionally, they think technology can be used for their own productivity and efficiency (e.g., word processing, database, and telecommunications).

The recurring motif in discussions concerning implementing technology into the classroom is training (Burkholder, 1985). Since it is the teachers who will implement technology, it is they who need the training. Burkholder notes that training needs include not only the rudiments of computing, but also the strategies necessary to integrate the use of technology into the curriculum.

Another often-cited issue in the literature is that of educational or school reform. Carey (1992) calls for a reform that incorporates the three components: vision, implementation, and maintenance. Addressing these concepts also was Oke (1992), who considered technology training for teachers "an on-going requirement of professional growth and a tool for education reform."

Carey (1992) offered a number of recommendations concerning educational technology. Teachers in training should be able to explore the technology and the instructional methodology and to integrate these into their curricula. They also need, once they are placed in a school, to develop patience, to find a comfort level, and to identify an internal expert to share with. She also recommends that teacher educators incorporate stated ISTE goals and afford teachers the opportunity to learn about instructional design, evaluation, and social issues of computing.

Burkholder (1985) calls for a teacher education program that includes an introduction to computers in education, potential uses of computers in education, skill development, and software evaluation. Oke (1992) has also called for evaluation strategies for teachers and has proposed computer literacy classes, modeling the use of the technology, and using telecommunications and distance learning to facilitate pre- and in-service teachers' implementation of technology.

Background

Over the course of 10 years, we have asked entering teacher education students to respond to a four-page packet when signing up either for testing to meet the required computer competency or for enrolling in the Computer Awarness Module, an instructional unit that helps them prepare for the competency test. In this packet they respond to a demographic sheet which asks for, among various types of information, their name, gender, major, and prior computer use. Prior Computer Use has been categorized as (1) None; (2) Using Content-Area Software; (3) Using Data Base, Spreadsheet, or Word-Processing Software; and (4) Using Programming Languages. The second and third pages include sign-up information for testing and for enrolling in one of the 10 to 14 sections of the Computer Awareness Module. The fourth page is the computer anxiety instrument (Palumbo & Reed, 1991), a 20-item, 1-4 Likert scale. The first and fourth pages have been optional (with the exception of their giving their name on the first page).

Sample

The research-participants in this study were 2,330 teacher education majors representing the following seven majors: elementary education (n = 967), secondary English (n = 259), secondary science (n = 193), secondary mathematics (n = 250), secondary social studies (n = 190), secondary physical education (n = 372), and special education (n = 99). The numbers do not reflect the total teacher education population at West Virginia University due to two factors: (1) completing the demographic and the computer anxiety pages of the packet was optional and (2) majors such as secondary art, secondary foreign language, and secondary music had so few students that including them in the statistical analyses might cause unreliable results.

Findings

The 10th-year data are presently being collected. The data for Years 1 through 9 are complete. Only Fall 1994 data are included; the Spring 1995 data will be collected in January and will be incorporated in the presentation. We have included the Fall 1994 data in the analyses so that we can discuss the findings within the 10-year context; we believe the Spring 1995 data will be similar to the Fall 1994 findings.

Based on a 10 (Year: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10) by 4 (Prior Computer Use: None, Content-Area Software, Applications Software, Programming Languages) analysis of variance, there were significant main effects on computer anxiety: Year (F[9, 2290] = 4.620, p < .0001) and Prior Computer Use (F[3, 2290] = 417.68, p < .0001). There was also a significant two-way interaction between Year and Prior Computer Use: (F[27, 2290] = 26.06, p < .0001). Essentially, students responding during the academic years 1985-1986 and 1986-1987 had higher computer anxiety than students responding during the academic years 1990-1991, 1991-1992, 1992-1993, 1993-1994, and 1994-1995 (see Table 1). Students with No Prior Computer Experience had higher computer anxiety than those students with Content-Area Software Experience who had higher computer anxiety than those with Applications Software Experience who had higher computer anxiety than those with Programming Language Experience (see Table 2).

Table 1. Computer Anxiety by Years

Year	1	2	3	4	5	6
Anx.	53	54	50	49	48	46
Year	7	8	9	10		
Anx.	47	47	46	48		

Note: Underlined numbers reflect significant differences between Years 1-2 and Years 6-10.

The two-way interaction was due to the computer anxiety of those students with Applications Software Experience being higher during Years 6 and 7 than those with Content-Area Software Experience. Other than those two instances students with Content-Area Software Experience consistently had higher computer anxiety than those with Applications Software Experience. Students with No Prior Computer Experience consistently had the highest computer anxiety across the 10-year period; those with Programming Language Experience, the lowest.

When viewing Major, interesting patterns emerged. Elementary education students had the highest computer anxiety, and the secondary mathematics and secondary science students had the lowest. The remaining majors—secondary English, secondary social studies, secondary physical education, and special education—comprised the middle group; that is, they had lower computer anxiety than the elementary education students but higher computer anxiety than the secondary mathematics and secondary science students. The computer anxiety of some majors decreased across the 10-year period whereas, the computer anxiety of other majors did not. Likewise, some majors entered with increasingly more experience at various points of the 10-year period; whereas, other majors did not.

Table 2. Computer Anxiety by Prior Computer Experience

	None	Content-Area Software
Anxiety	*58*	*52*
	Applications Software	Programming Language
Anxiety	*44*	*32*

Note: Numbers in italics reflect significant differences among all four types of Prior Computer Experience.]

There were also significant main effects of Gender and Year on Computer Anxiety: Gender (F[1,2310] = 14.62, p < .0002) and Year (F[9,2310] = 8.460, p < .0001). Both males' and females' computer anxiety significantly decreased across the 10-year period with males' computer anxiety being consistently lower.

The presentation will focus on the more intricate patterns in the data, specifically how particular majors changed in terms of computer anxiety and prior computer use. Cases of extreme differences will be showcased.

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Turning Points: The Effects of Staff Development Using Technology in Professional Development Schools

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Restructuring in education is most commonly understood to be the reorganization of schools via the implementation of programs that facilitate changes of the school's structure and performance in meeting students' needs (Fullan & Stiegelbauer, 1991; McGee-Banks, 1993). Restructuring of schools is not a theory but specific strategies geared to affect positive, measurable student educational outcomes (Newman, 1993).

An effective means for restructuring schools is technology integration (Collins, 1991; David, 1991; Sheingold, 1991), and an essential component of Goals 2000 (U.S. Dept. of Education, 1994). Technology is defined as computers, communications and video technology (Anderson, 1993). Dramatic gains in the acquisition and utilization of technology in schools has occurred since the educational reform movement of the eighties. According to Anderson (1993), ninety-nine percent of the schools in the United States have computers.

The International Association for the Evaluation of Educational Achievement (Anderson, 1993) reports that the United States leads other nations in the ratio of students to computer and in providing students more opportunities for computer learning experiences in traditional subjects. The US student has less opportunity to learn practical computer knowledge since the US does not require a formalized computer curriculum (Anderson, 1993). Computer classes are primarily offered as electives in comparison to Western Europe's formalized computer curriculum. Hence, American students are less computer-knowledgeable than their counterparts in the Netherlands, Austria, and Germany (Anderson, 1993).

Anderson (1993), reports that teachers in the United States are less knowledgable and less experienced in computers than their European counterparts. Less than half of the U.S. schools reported that their teachers are provided opportunities for technology training at their colleges and schools(Anderson, 1993).

Staff development is commonly practiced in school districts throughout the United States as a means for enhancing faculty performance and student achievement. By providing teachers opportunities to increase their knowledge and expertise in content, instructional strategies and management skills, students' learning experiences and achievement levels would be enhanced (Hargraves & Fullan, 1992; Joyce & Showers, 1988). Goodlad's premise of "a natural connection between good teachers and good schools" (1990, xi) is a major tenet in school restructuring. Hence, technology is an effective vehicle for restructuring through its ability to change students' learning experiences; to change the professional lives of teachers; and to change the governance and management of schools (Newman, 1993).

Context

The Texas Education Collaborative (TEC) is a Center for Professional Development and Technology which was funded by the Texas Education Agency in the Fall, 1992.

Two of the primary objectives of the TEC were:

- To obtain, implement, and investigate evolving technology systems at participating school sites and the Colleges of Education
- To provide staff development regarding instructional technology for these systems.

The TEC is comprised of Texas A&M University, PrairieView A&M University, Blinn College, Region IV and Region VI Service Centers, and five school districts: Bryan ISD, College Station ISD, Conroe ISD, Somerville ISD, and Waller ISD. Three elementary schools, three middle schools, one junior high school, and one high school which are representative of the state's diverse backgrounds with respect to cultural, social and economic indicators. comprise the eight original sites of the TEC. The following table provides descriptive data on each school.

Table 1
Information on Participating Schools.

School	Grade Levels	Enrollment	Teachers
SV	K- fourth	554	36
RR	K-fourth	443	37
AJA	third-fifth	549	30
JI	fifth-sixth	443	32
JLM	sixth-eighth	852	66
SJH	sixth-eighth	187	17
WJH	seventh-eighth	889	64
AMC	ninth-twelfth	420	110
Total		5,337	392

Since the project began in November, 1992 expenditures totaling $1,960,907 dollars were spent to establish a technology infrastructure among the collaborative sites, with an additional $627,836 dollars spent for professional staff development training.

A site coordinator was funded to serve as a university liason and the school's technology troubleshooter and coach. This position enabled the teacher/site coordinator to be released from the classroom to assist other teachers in integrating technology in their instruction. The site coordinator was also responsible for keeping records regarding the school's technology infrastructure and documentation of staff development activities and teacher involvement in technology for their school.

The medium for providing local governance and ascertaining the direction of technology within each respective school was the site council. The site council was an advisory group comprised of the site coordinator, the principal, a representative from the regional service center, two teachers, a parent, and a business partner. Meeting regularly to assess and facilitate the changes involved in the restructuring process, the site council made the primary decisions regarding the budgets, developing the technology instrastructure and implementation of technology, and planning staff development for their campuses. This has resulted in each school evolving different technology programs.

The autonomy of the eight professional development schools is evidenced in the different stances taken toward staff development and the technology infrastructures established within the respective schools. The technology infrastructures varied among the eight schools.

Staff Development Training

Since teacher development plays a prominent role in enhancing faculty performance and student achievement, staff development training in instructional technology was a major facet of the restructuring movement. The needs assessment conducted during the proposal writing period helped determine teachers' technology competences.

Table 2.
Needs Assessment Spring 1992*

Word processing:	58%	Distance learning:	3%
Desktop publishing:	24%	Video discs:	.6%
Hypercard/Linkway:	.7%	Telecommunications	17%
Spreadsheets:	21%	LCD Panels:	.6%
Tech. presentations:	.7%	CD-Rom:	.6%
Computer graphics:	26%		

*Percent of respondents indicating experience with software/ hardware.

Findings assessing teachers' competencies regarding technology from the 143 teachers who responded to the survey determined that half of the teachers had some experience with word processing software and 25% of the respondents had some experience with spreadsheets, graphics, and desk top publishing. Experiences with telecommunications, multimedia, and instructional technology were neglible. Nearly all of the respondents (98%) reported needing instruction in and access to new technologies. Teachers overwhelming reported needing strategies for using technology and encouraging its use with their students.

These results suggested that schools would derive benefit from a skilled technology coordinator who would provide weekly half-day staff development training in instructional technology for the teachers. The technology coordinator would provide extensive training, and the coaching necessary for teachers to integrate technology within their curriculum. The results of these first year weekly half day sessions enabled 269 classroom teachers to become proficent in using computer hardware and software programs.

Weekly staff development training for both years has centered on the following software and hardware applications: MacIntosh Basics, Hypercard, ClarisWorks, Quick Time Movies, Aldus Persuasion, Screen Play; and laser disc players, CD ROMs, and scanners. Teachers were most actively trained in using word processing, graphics, spreadsheeet and data base by the assigned university technology coordinators.

During the second year, the protocol changed whereby school sites would schedule the time and topic for the staff development for presentation by the university coordinators. Collectively, 38.5 days or 1446 hours of instruction were provided by project staff on technology applications.

Compressed video systems were established during the second year of the project at Anson Jones Academy, Jones Intermediate, Somerville Junior High, Southwood Valley Elementary, and Washington Junior High School and Prairie View A&M University and Texas A&M University. Following installation, staff development training was provided to participants enabling immediate school to school videoconferencing connections within the collaborative.

Findings and Conclusions

Data collected on the effects of staff development using technology in the eight professional development schools have been very positive. Evidence gathered from school records indicates that 135 teachers regularly use instructional multimedia and 263 teachers use computers for word processing each week. Also, records indicate that 53% of the students use computers daily and the level of use increases to 74% if weekly use is considered.

Reading, language arts, science, social studies, and math were the primary subjects where technology was applied in instruction. Computer technology was also used in an array of subjects such as foreign languages, theater, and ESL. Teachers commonly used technology for classroom management, grading, developing tests and worksheets, learning activites, and tutorials. Multimedia and slide presentations were used in developing curriculum units. The site councils listed staff development training as their major priority for both years. Scheduling and motivating teachers to participate in staff development opportunities was a dilemma on many campuses.

A primary source of frustration was the discrepancy in levels of technology expertise among teachers at some schools. Staff development on technology basics was still being conducted at some schools by university coordinators for teachers who were unwilling to learning the skills without their assistance. This hindered the coordinators' time to work with more motivated teachers in advancing their skills in instructional technology. Another problem encountered by the technology coordinators was trying to motivate some teachers to focus on pedagogical concerns regarding integrating technology within the curriculum rather than how to use the software packages.

Each school's autonomy concerning staff development training and technology implementation has resulted in teachers' varying levels of expertise and alignment of the curriculum with technology. This may be attributed to the site council's leadership and the school's personality and culture. Whereas several schools have entire faculty trained in using technology and are successfully integrating it within their curriculum; a large number of teachers at other sites remain at the primary level.

One site coordinator whose campus is lagging in comparison to the other sites in technology -trained and motivated teachers wrote, "Personally, in the future, I would require teachers to have a certain level of training and proficiency before computers would be placed in their classrooms. Use of the computer for instructional purposes would have to be documented. I would make having a computer a use it or lose it situation."

Staff development training at this campus was conducted as a "come and go affair." This site coordinator left after the first year. Since no teacher wanted to assume the site coordinator position during the second year, the school went without a skilled site coordinator until the second semester. Now this site coordinator has left, and the school is still grappling with the same issues. Recent Fall, 1994 data report that 30% of their students use computers weekly; 15% daily, and an estimated 15 teachers use wordprocessing and 6 teachers use multimedia weekly.

The training gained through the TEC has provided faculty in various schools motivation to continue developing their technological skills. In some schools, entire faculty were trained and were highly involved in integrating technology throughout the curriculum, especially through the development of multimedia units. Staff development training continued at these schools throughout the summer. School representatives also began staff development training for other district faculty in technology.

Training for the compressed video systems have enabled connections to be established among schools and universities. Students in classrooms located in different communities have been able to work together on learning projects. Mathematics, reading, and science classess have dominated the 28 sessions of classroom connections during the first three months of operation.

Throughout the TEC's evolution, teachers have been positive regarding staff development and technology. Teacher responses on open-ended surveys have been revealing. A high school teacher noted "an esprit de corps" developing among their faculty and "the respect they [teachers] gained for one another while working together" developing thematic curriculum. The coordinator wrote, "To see teachers from all disciplines working excitedly, professionally, and respectfully was a joy, both to them and to the administator in charge." An elementary school reported about how their teachers are "so interested in technology" and excited about being on the "cutting edge." Faculty "willingly give up their conference period" . . . "which all gave up gladly to learn more about computers." An intermediate school recorded their teachers having "pride of being perceived as being on the cutting edge of educational technology."

Consensus occurred on open-ended surveys regarding increased motivation among students and teachers. Teachers report more efficient use of time for management and instruction. Other insights were how technology "increased the excitement" and "engagement of students in learning"; "addresses all learning styles" and how "students are 'producers' in their own education instead of consumers. Teachers from an intermediate school found that there was 'less reliance on traditional texts' and less ability grouping than prior to the introduction of technology in this school.

One school's principal commented how her own perceptions have changed with the TEC, since she now interviews potential faculty on "what can they do with technology." This principal reported that younger faculty assimilate technology within their teaching more easily in contrast to older faculty, since older faculty grapple with "how can I integrate technology with what I am already doing?" This principal noted that her district's curriculum is being rewritten because of the the restructuring that has occurred. An elementary school whose faculty have benefited from TEC's staff development training and technology infrastructure feeds into their school. With these students coming to her school more "technologically advanced" than their curriculum, they are revising and rewriting it daily.

The change in teacher performance is changing student performance. Besides teachers "customizing curriculum" for some of their students, many use authentic assessment for evaluating student performance. Junior high school teachers report that technology has assisted their students in obtaining greater mastery of more difficult skills. Numerous site teachers recount students show greater interest and appear to have motivation for learning.

Students reported that they like the simplicity and speed of the computer screen for research, and the utilization of the computer screen for demonstrations of science experiments and new software packages. Students at two junior high schools, an intermediate school, and an elementary school regularly use the scanner, camcorder, and multimedia to produce their assigned projects. As one American history teacher commented, "It (technology) brings assignments to life. Students learn more when they can see things move and change instead of just reading about it in their books."

Table 3.
Fall, 1994 Level of Use of Technology Survey

The estimated number of teachers using:

	computers for word processing 263	multimedia weekly in instruction 135
AMC High Sch.(110)*	75	40
S. Junior High(17)	17	7
W. Junior High(64)	55	20
J.L. Middle(66)	15	6
A.J. Elementary(30)	12	5
Southwood Valley(36)	36	36
R.R. Elementary(37)	23	5
J.I. Intermediate(32)	30	15

* Numbers in parenthesis indicate the total number of teachers in the school.

The estimated number of teachers regularly using the following:

	Scanner	Telecom.	HyperText
AMC High School(110)	40	40	40
S. Junior High(17)	5	15	2
W. Junior High(64)	4	7	NA
J.L. Middle(66)	NA	NA	6
	Scanner	Telecom.	HyperText
A.J. Elementary(30)	5	5	3
Southwood Valley(36)	17	7	15
R.R. Elementary(37)	3	4	2
J.I. Intermediate(32)	20	10	20
Total	94	88	88

Estimated Percentage of Students Using Computers

	Daily	Weekly
AMC High School(1420)	40%	60%
S. Junior High(187)	80%	100%
W. Junior High(889)	60%	95%
J.L. Middle(443)	15%	30%
A.J. Elementary(549)	100%	100%
S.V.Elementary (554)	77%	100%
R.R. Elementary(443)	25%	100%
J.I. Intermediate(443)	30%	50%
Mean	53%	79%

Preliminary analysis of the values in the preceding table indicates that the technology infrastructures and staff development training offered by the TEC has effected change in teacher performance at the eight schools. This is evidenced in the numbers of teachers trained in using technology, the number of teachers who are now using it in teaching, and the restructuring of curriculum which is transpiring at the school sites. Testimonials from teachers indicate a personal revitalization of the profession resulting from the retooling of skills and alignment with the TEC. Learning is slowly changing to a more student-centered approach, as students become more independent producers of products which are authentically assessed.

Yet, the autonomy, leadership, and culture of schools cannot be ignored, since it has resulted in the discrepancies between the participants' level of use of technology. Differences exist in the purposes and utilization of technology. These differences need to be assessed and analyzed in reference to the teaching process and performance levels of teachers.

For us, the questions arising are, "How has the technological implementation of teaching changed the learning process?" "How much has teacher performance changed in reference to increasing student achievement scores?" Gains presently are minimal in relation to the two million dollar outlay of expenditures according to the statewide Texas Assessment of Academic Skills Test. Are teachers "walking the talk?" This is the fundamental question that must seriously be answered.

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Relationships Among Experience, Philosophy and Beliefs Related to Calculator Use

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Previous studies (Fleener, 1994a, 1994b) suggested conceptual mastery before calculators are used for mathematics instruction was a divisive issue for middle school and secondary mathematics teachers. A follow-up study (Fleener, in press, a) found fundamental philosophical differences between teachers who were divided on the mastery issue. Philosophical differences between teacher groups were determined by examining Habermasian interests expressed through responses to the researcher-constructed survey, Attitude in Mathematics and Applied Technology-Version II. A fourth study (Fleener, in press, b) compared preservice and practicing teachers' beliefs about calculator use in order to infer the role experience plays in forming attitudes about calculator use. Findings revealed an interaction between philosophical orientation as expressed by responses to the mastery issue and experience as determined by teaching category (preservice versus practicing teachers). This line of research suggests inservice efforts may have differential affects on teachers based on experience and philosophical orientation. While other studies have addressed the importance of experience when formulating opinions about technology use (Hunt & Bohlin, 1993), the relationship between experience and philosophical orientation has only been suggested.

Research Questions

This study investigated changes in student beliefs about technology use in elementary mathematics teaching during a semester-long mathematics methods class. The interactions among philosophical orientation, beliefs, and experience were examined by comparing student responses on the Attitude Instrument for Mathematics and Applied Technology-Version III (AIM-AT-III) at the beginning and end of the semester. Guiding questions for this study were:

1. What are preservice elementary education majors' beliefs about the importance of teachingcalculator skills to elementary students?
2. What is the interaction among philosophical orientation, beliefs, and experience of preservice teachers associated with calculator use for mathematics instruction?

Methods

Participants

Sixty-three preservice elementary education majors participated in this study. All were enrolled in one of two intermediate-middle school mathematics methods classes taught during the spring semester, 1994 by the investigator. They were concurrently enrolled in science, social studies, and reading methods courses and were in their last semester of coursework before student teaching. The majority of participants were non-hispanic Caucasian, 6% were Native American, 2% were African American, and 3% were Hispanic. One student was male.

Procedures

On the first and last nights of classes, students took the AIM-AT-III. Because prior research suggests technology-intense units of study in methods classes may not be as valuable as integrated calculator use (Fine & Fleener, 1994), the class was organized to include weekly activities that utilized calculators. Although many students had calculators of their own, calculators were made available during all classes. Student projects included developing and designing a poster-board display of a cooperative learning-calculator activity consistent with the focus of the National Council of Teachers of Mathematics (NCTM) Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989).

Instrumentation

The AIM-AT-II was revised to investigate student beliefs about teaching calculator skills. Three items were eliminated from the AIM-AT-II and replaced with items addressing the importance of calculator skills for the 21st century. These items were:

3. Working with calculators is not necessary for future career success.
13. Mathematics teachers should teach calculator skills.
29. Learning to use calculators is necessary for succeeding in the 21st century.

Three additional items from the AIM-AT-II were replaced and one was reworded because previous investigations revealed ambiguities associated with interpreting the items. (See Fleener, 1994b for details concerning the construction and reliability of the AIM-AT-II). Students responded to AIM-AT-III items using a forced response Likert scale with Strongly Agree, Agree, Disagree and Strongly Disagree options.

Analyses

Responses to item 13 were compared with responses to items 3 and 29 on pretest and posttest administrations of the AIM-AT-III in order to determine the answer to research question 1. Since there was consensus (see Fleener, 1994a) on each of these items, only strongly agree (items 13 and 29) or disagree (item 3) percentages were compared to determine shifts in intensity of beliefs.

In order to answer the second research question, student pretest and posttest results were compared according to expressed changes on the mastery issue. Previous research suggested teachers (Fleener, 1994a, 1994b, in press a) and preservice teachers (Fleener, in press b) were divided on the issue of whether students should have conceptual mastery before being allowed to use a calculator. Further investigation revealed teachers' beliefs about the mastery issue were indicative of fundamentally different philosophical beliefs from a Habermasian perspective (Fleener, 1994b, in press b). Students were categorized into *mastery=yes*, *mastery=no*, and *mastery=maybe* groups depending upon whether their responses to mastery items were consistent with the belief that students should or should not have conceptual mastery before being allowed to use calculators. Pretest and posttest changes in mastery categories were noted to address the second research question.

Results and Discussion

Students were committed to the belief that children should have calculator skills in order to survive in the 21st century and felt strongly that mathematics teachers should teach calculator skills. Although general agreement with the importance of calculator skills was expressed on the pretest, student responses were more positive on the posttest after a semester of integrated calculator activity. This was especially apparent on item 13 where 60% of the students strongly agreed calculator skills should be taught by the mathematics teacher, up from 25% strong agreement on the pretest. Similarly, strong disagreement with item 3 and strong agreement with item 29 changed from 45% and 40% respectively on the pretest to 59% on the posttest.

As suggested by prior research (Fleener, in press b), there appears to be a continuum of responses determined by the mastery questions which affect how calculator experiences are interpreted. Only 2 students from the mastery=no group on the pretest changed to mastery=maybe or mastery=yes responses on the posttest and no student from the mastery=maybe group responded consistent with the mastery=yes group on the posttest. Forty-eight percent of the students indicated shifts along the continuum from *mastery=yes* to mastery=maybe (24%), *mastery=maybe* to *mastery=no* (13%), and *mastery=yes* to *mastery=no* (11%) categories. The remaining 49% did not change mastery orientation from pretest to posttest. Thirty percent remained committed to the need for conceptual mastery before calculators were used (*mastery=yes*), 13% felt mastery was not necessary before calculators were introduced, and 6% remained mixed on the issue.

These results suggest there is a relationship among philosophical orientation, beliefs, and experience of preservice teachers related to calculator use for mathematics instruction. While only about half of the *mastery=yes* group changed their view that conceptual mastery was necessary before instruction with calculators was permissible, over two-thirds of the *mastery=maybe* students changed opinion, all to the belief that mastery was not necessary. Furthermore, that only 2 students changed from *mastery=no* orientation suggests methods class experiences with calculators served to confirm their thinking and matched their prior beliefs about calculator use also suggesting this group of students may make better use of the ideas presented in methods classes pertaining to calculator use.

Significance

Previous research (Fleener, in press b) indicated there was an interaction between experience and philosophical orientation which suggested instruction with calculators might affect individuals differently depending upon mastery orientation. Because the previous study compared preservice and practicing teachers, however, specific changes in beliefs and practices could not be addressed.

This study compares the same group of preservice teachers before and after a semester of integrated calculator activities. It appears there is in fact a difference between mastery groups with regard to how calculator experiences affect beliefs about the use of calculators in mathematics teaching. Yet to be determined, however, is the effect these differences may have as these preservice teachers join the ranks of the teaching professions.

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Research Project: An Appraisal of the Impact of Nebraska's Statewide Internet Implementation

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The purpose of this paper is to provide an overview related to Nebraska's K-12 Internet Evaluation Project, undertaken cooperatively between the University of Nebraska at Omaha and the Nebraska Consortium of Educational Service Units. The project is funded in part by the U.S. Department of Education. The project is in its first year, and the evaluation model being used has been developed and tailored to the situation in Nebraska. This paper overviews the developed model, as well as some initial results from the first six-month reporting period.

The following are the goals of the Internet Evaluation Project which focus on long range research and assessment, targeted at five years, of the integration of the Internet in the K-12 Nebraska schools and the support related to this integration delivered by the Nebraska Educational Service Units. The goals for the first six months of the project are to:

1. Design, organize and begin a formative evaluation and action research process
2. Design and implement a pre-training survey for newly trained teachers
3. Develop a format for gathering machine usage data related to the Internet
4. Begin to collect examples of innovative classroom uses of the Internet
5. Report on the initial six month progress of the evaluation process
6. Submit external funding proposal(s) to enhance the evaluation process

Background

The Internet is the world's largest computer network. It was born more than 20 years ago as a U.S. Defense Network, with the purpose of supporting military research, through a communications structure which could survive a limited nuclear attack. In the late 1980's the National Science Foundation expanded the network to encompass scientific and higher education institutions. Since that time the Internet has expanded commercially and internationally, and is now resident within more than 140 countries worldwide (Calcari, 1994; Pawlowski, 1994), and links at least 5,000 computer networks and over 300,000 host computers (Kearsley, 1993). The Internet provides the efficient exchange of computer-based data across the globe. In addition, it provides users access to a wide variety of long range network based computing (called telecomputing) activities, including direct access to electronic mail, network supercomputers, and extensive on-line databases, software, and newsgroups.

Although the Internet was initially envisioned as a "data superhighway" for the government, scientific, and higher education institutions, K-12 schools and school districts are now showing a real interest in being a part of the Internet and its related telecomputing activities.

For the K-12 classroom, the Internet access offers the potential of "breaking down the classroom walls", and linking a classroom microcomputer with any computer on this international network. Thus, a fifth grade student in Fort Calhoun, Nebraska might exchange electronic mail with a fifth grade student in Melbourne, Australia, or receive actual pictures of Mars from NASA, or perhaps search a national database for the most recent U.S. Supreme Court ruling. It is anticipated that the Internet will parallel or exceed the substantial adoption into education of the classroom microcomputers (Krol, 1993).

Although K-12 teachers are beginning to have access to the Internet, much of their current activities are facilitated by the knowledge, equipment, and motivation of individual teachers. However, statewide support in the nation is increasing, and many states are beginning to envision statewide plans for supporting at least some type of general technology network (television, satellite, telecomputing, etc.) for their resident schools and districts. In addition, nine states have been identified as possible leaders in K-12 telecomputing planning and adoption, as they already set up early statewide plans (Kurshan, 1990; McAnge, et. al., 1990; Web Associates, 1993). These states include Arizona, Florida, Indiana, New Mexico, Pennsylvania, Texas, Virginia, West Virginia, and Nebraska. Yet this core group includes only nine of the nation's fifty states (18%); and many of the other states will look to this core group for input related to their ongoing statewide efforts.

The state of Nebraska is now in a position to add to the emerging national picture of telecomputing use and potential for K-12 education, and carefully examine its own approach to impacting student learning through statewide use of the Internet. Nebraska has long had a strong support network of 19 Educational Service Units, which have since 1966, provided the state's public schools with many resources, including significant computer data and information services (Nebraska Educational Service Units, 1991). Building on this statewide expertise, the Nebraska Legislature recently passed Legislative Bill 452, which authorized the local educational service units to levy an additional property tax to support the introduction of Internet equipment and teacher training for Nebraska schools. This statewide effort has recently begun, and the Educational Service Units are now working with their local school districts to bring them on-line (Nebraska Department of Education, 1993).

A research team from the University of Nebraska at Omaha have been contracted by the Nebraska Educational Service Units to evaluate this statewide approach to Internet connections for schools. This team, directed by Dr. Neal Topp and Dr. Neal Grandgenett, is currently investigating action research questions that include: What is the frequency and patterns of Internet usage by teachers and students in the state of Nebraska following teacher Internet training? Is the usage pattern spreading? Are trained teachers sharing their expertise with other teachers? Are there relationships between teacher characteristics, teacher perceptions, and teacher Internet use? Does the Internet impact the role of teachers? How does Internet usage impact students and their learning? How do teachers perceive Internet usage to be impacting schools? (i.e. does Internet usage contribute to breaking down the walls of the classroom?) What are the strengths and weaknesses of the Nebraska model for involving Internet in K-12 education? Within the partnership with the Nebraska Educational Service Units, the University of Nebraska at Omaha research team is coordinating the evaluation project, and the Educational Service Units are facilitating the data collection procedures. The evaluation process is both formative and comprehensive in nature, and will be ongoing for at least the next five years.

As a national leader in K-12 integration of the Internet, Nebraska is aware of the responsibility of carefully documenting the implementation model and effectiveness of its K-12 telecomputing activities, as these activities impact upon the classrooms and students of Nebraska. This is the purpose of the Nebraska Internet Evaluation Project. The more we know about the success and failure of statewide Internet activities in K-12 contexts, the better able we will be to help all students and teachers use the Internet to its full potential, not only in Nebraska, but in the United States as a whole.

Design of the Evaluation

The design of the evaluation is essentially that of an "impact analysis." In evaluation studies, impact analysis can be defined as meaning "determining the extent to which one set of directed human activities affected the state of some objects or phenomena, and . . . determining why the effects were as large or small as they turned out to be" (Mohr, 1992, p.1). In this evaluation project the evaluation design is focused on the action research questions which seek to determine the general impact of the Internet, and Internet training, facilitated by the Educational Service Units, on K-12 education in Nebraska, or specifically on teachers and their students in the classroom.

Within the evaluation three primary types of data are being examined related to the research questions. These data types include 1) teacher survey and interview data, 2) machine usage data, and 3) documented classroom uses. Initial evaluation goals were associated with making progress in each of these three areas. Descriptive statistics are used currently in the six-month formative stage of the evaluation process, with correlational and pattern analysis targeted for later reporting periods. The initial progress in each of the three data areas are summarized in the following subsections.

Preliminary Progress of Survey Analysis

To help get baseline information and perceptions from teachers before they received the Internet training offered by the Nebraska Educational Service Units, a 30 question survey was developed. This survey was designed to be read by NCS scan equipment, so that a single sheet could be provided at the beginning of the training sessions. It was field tested and refined based on teacher and trainer feedback.

Initial incorporation of the survey into the training program as the Educational Service Units begin their training activities has been excellent, and a total of 767 surveys were summarized for the initial six-month reporting period. The next reporting period, in January 1995, will include over 3000 returned surveys. The surveys will continue to be given as teachers are trained across the state, to provide pretraining baseline information from teachers. A six-month follow-up survey to the trained teachers was also developed, and used both Likert scale and open-ended responses. This second survey is in the process of being returned, and was sent by both electronic and ground mail. Eventually, after all Educational Service Units have initiated training activities and contributed survey data, a detailed correlational analysis, and interpretation by an advisory committee, will be conducted related to the information.

Preliminary Progress of Machine Analysis

An important component of the evaluation process will also be to examine the general server usage established by the Educational Service Units to support K-12 Internet access in the state. With the help of some technical specialists, software is being developed which will electronically report server usage data at the end of each month from each of the Educational Service Units, to be used in an automatic monthly report. The target date for full implementation of this data collection procedure is by the end of the first year (January, 1995), and permission was recently received to implement the related data collection process. This information will also facilitate some of the follow-up surveys and interviews. The reporting software is currently being developed, and will record information related to monthly account totals, CPU usage, total logins, and patterns in system use.

Preliminary Progress of Innovative Use Summary

Another component of the evaluation is to document some of the innovative uses of the Internet in K-12 classrooms in Nebraska. These uses will be in an "annotated list" format, eventually available over the Internet. Innovative classroom uses existing in Nebraska are being identified with the assistance of the two electronic surveys, as well as follow-up phone interviews. Classroom observations, documented via videotapes, will also be conducted as the situation warrants.

The evaluation team is also working with the Consortium of Educational Service Units to develop a Mosaic page format for linking to innovative student and teacher examples, to operate as an "electronic portfolio" of innovative uses which fit this particular format. The Mosaic page will also provide an update on the current evaluation progress and relevant statistics, and will be freely accessible by everyone who wishes to learn more about what is happening related to the Internet in Nebraska. The Mosaic page is targeted to be online by the third reporting period (July, 1995).

Implications from the First Survey

The evaluation process is in in its preliminary stages, and is currently focusing on refining the evaluation process and data collection procedures. However, several implications and recommendations were already apparent from the initial descriptive statistics and observations of the first pretraining surveys. These initial recommendations from the first six-month reporting period are listed below.

A variety of teachers are becoming involved in the training.

This is apparent from the wide range of initial demographic information related to the pre-training teacher surveys. The mix of teachers indicated that initial participation in the training process is inclusive to most groups and levels of teachers.

A wide variety of computer-related background skills exist for teachers entering training.

It is apparent that little can be assumed related to what teachers already know about computers, or the Internet in particular, when entering Nebraska training. Responses to Internet related questions suggested that Nebraska teachers know very little about the Internet before beginning the training process.

Teachers bring very little knowledge related to their planned integration of Internet into the classroom.

Based on their responses to an open-ended question regarding expected use, it is apparent that the first group of Nebraska teachers to be trained are entering training with virtually no personal plans or expectations related to integrating the Internet into their classrooms, or how they might eventually use the Internet with their students. It was recommended that training activities should continue to recognize this low level of initial teacher awareness and expectation, and plan for the continued support of classroom use.

The first teachers being trained seem to have a "student involvement" philosophy.

This is indicated by the responses to questions related to student projects, research, and group work. The teachers stepping forward to initially be trained appear to generally support non-traditional and student-centered activities in their classrooms.

The keyboarding or typing skills of some teachers is a possible problem.

This is indicated by the small but significant percentage of teachers entering training who rate their keyboarding skills as "slow" or "very slow." This 10% of the respondents may find Internet use to be a particularly difficult challenge.

There are already some innovative uses of the Internet underway by Nebraska teachers.

Innovative uses of the Internet are already emerging from the Nebraska area, and several teachers are involved in lessons which are worthy of national level recognition. It was recommended that some consideration be given to the best way to use these "success stories", for assisting statewide implementation of the Internet.

There seems to be exceptional cooperation among Nebraska institutions at this time related

to implementation of LB 452.

In its first report, the evaluation team noted a very high level of cooperation among the Nebraska Educational Service Units, as well as other contributing organizations, such as the University of Nebraska, the Nebraska Department of Education, and the Nebraska Legislature. This was apparent from the joint activities related to hardware and software consulting, the joint collection of innovative lessons, the development of a joint training manual, and the shared planning related to statewide training and evaluation.

Summary

It was apparent from the initial six month reporting period, that the state of Nebraska has made an excellent start on a very difficult but worthwhile task. It is a difficult task, because Nebraska is truly ahead of most states in trying to bring the Internet into K-12 classrooms, and in particular, legislatively funding the activity, so there are few others to look to for guidance. It is a worthwhile task, because of the Internet's very exciting potential for impacting education in the state of Nebraska, as well as the nation. It would seem that the Internet does provide a chance to truly break down the walls of individual classrooms, and to make available the vast sources of information around the world. This is particularly important in Nebraska, a state with a relatively small population, but the most individual school districts of any state within the United States.

As the formal evaluation project continues to evolve, a unique opportunity is provided to examine how an entire state confronts one of the greatest innovations and challenges that has come to education in some time. The evaluation process itself will help teachers from the field to have a collective as well as individual voice regarding the progress of this new challenge, and what can be done to help ensure that these teachers are supported effectively.

The formal evaluation process will continue to be refined and expanded as the amount of data grows, and as teachers are trained and attempt to use the Internet in their classrooms. Like the Internet, the evaluation process will be dynamic rather than static. Yet the underlying purpose of the evaluation project will remain unchanged, which is fundamentally to help the students of Nebraska receive the maximum benefit of the resources being brought to bear on their behalf, and to help bring them into the 21st century of education, through an effective integration of the Internet into the K-12 classrooms of Nebraska.

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Field-Based Student Attitudes and the Integration of Technology

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Through initial seed grants from the Texas Education Agency, teacher certification institutions throughout Texas created Centers for Professional Development and Technology in the early 1990s. The Northeast Texas Center for Professional Development and Technology (NET-CPDT) was created at East Texas State University (ETSU) in Commerce to provide, through a collaborative commitment, relevant field-based teacher education and staff development programs in a way that integrates research-supported innovative teaching and assessment practices with technology. Of the initialsix goals of the collaborative, two goals focus on technology. One focused on the increased use of technology for instruction and a second focused on the integration of technology with best teaching practices in a more effective manner (Stetson, 1994).

While at least 1,200 partnerships have been established between schools and universities (Wilbur and Lambert,1990), the relation between universities and schools has been characterized as a "fickle romance" (Wiske, 1989). Concerns such as ownership, outcomes, the active involvement of teachers, equal commitment and leadership to the effort, and equal gain from the effort need to be addressed (Allum, 1991; Wiske, 1989). Fortunately, the collaborative efforts were well addressed and successfully implemented in the first two years of the collaborative effort (Riner, 1994). Grant monies provided for the purchase of hardware and software. The NET-CPDT Coordinator of Technological Services provided support for the installation of the hardware and software and inservices activities for the inservice and preservice teachers. Regular faculty members recognized the importance of technology within the undergraduate curriculum and encouraged its use in instructional settings and for evaluation. Use of technology for classroom management, curricular development, and instruction was emphasized. Students were encouraged to use the basics of technology such as word processing, database management, and spreadsheets. Students were also encouraged to use the slide presentation package associated with Clarisworks.

However, in the same External Evaluation Report, Riner (1994) posited that technology is not perceived as a major benefit or a strong motivator for participation in the collaborative effort. The technology placed more demands on time and effort on the part of the inservice teachers. Instructors in the field-based program also noticed a lack of interest and enthusiasm on the part of the preservice teachers to embrace the use of technology. As a result, the integration of technology into the field-based program did not seem successful. This observation sparked an initial investigation to determine the possible reasons for the lack of integration of technology into the field-based program.

Researchers have identified variables that account for how well educators integrate technologies into the curriculum, including administrative support, pedagogical orientation, professional training, and collaborative partnerships (Ritchie and Wiburg, 1994). The NET-CPDT program provided the administrative support and professional training for the inservice and preservice teachers. The pedagogical background of effective teaching practices and the use of the computer in effective teaching situations were demonstrated and used as part of the delivery method. Inservice and preservice teachers were encouraged to participate in the design of technology. It seemed that the participants had opportunities to become effective teachers using the latest technological advances. Although some teachers may have similar perceptions of what it takes to become an effective user of computers for instruction, those teachers who have a stronger commitment to instructional computing use the computer more often and in more effective ways than other teachers (Vockell, Jancich, & Sweeney, 1994). Thus, the teachers' attitudes make a difference.

Acknowledging the importance of the participants' attitudes toward technology and recognizing that this collaborative effort involved two distinct groups of participants, inservice and preservice teachers, this study focused on the preservice teacher. The researchers based this decision on the fact that some of the researchers (1) shared responsibility for the training of these preservice teachers, (2) recognized that there was a lack of information on preservice teachers' attitudes, and (3) found most prior research studies have drawn their subjects from required computer classes or from self-selected elective courses (McEneaney, Soon, Sprague, & Linek, 1994).

The Sample

The preservice teachers in the ETSU teacher education program complete a two-semester intern/resident field-based program. Although traditionally, the preservice teacher was minimally exposed to technology through a core curriculum computer course offered through a separate department, a critical component of the new program is instructional technology. In designing the instructional component of the field-based teacher education program, some attention was given to the subject matter content and knowledge of current software and hardware. However, the field-based component also permitted opportunities for preservice teachers to be paired with mentoring teachers who were trained in instructional technology, had access to computers because of grant monies, and used computers in their classroom because of the support of instructional technology faculty. Because of its inherent collaborative nature and the strong role of the mentoring teachers, an assumption of more positive computer attitudes among this group was posited.

The Research Design

The research design of this study was an attempt to answer the following questions:

1. Are there any differences in participant attitudes about computers at the end of their intern semester?
2. Are there any differences in participant attitudes about computers at the end of their field-based experiences?

The research design used for this study was the classical pre-test, post-test design with data gathering from a computer attitude scale at the beginning and end of each semester — the intern semester and the resident semester. At the beginning of the intern semester, the computer attitude scale (see Appendix A) is administered to each intern and then readministered at the end of the semester. The process is repeated during the second or residency semester. The design can identify differences between the students' initial induction into the field-based program and at three distinct points in their development. In order to identify any differences, analyses of variances are used.

In the ongoning study, once any differences are identified, qualitative data will be gathered to identify the reasons for these differences. Demographic data, such as their degree, year of study, and age, is also being gathered.

The Computer Attitude Scale

The instrument, the ETSU Computer Attitude Scale, is a data-gathering instrument that consists of 36 statements referring to the students' attitudes about computers. Each participant is asked to react to the statement in a Likert-type method with five possible responses: A=strongly agree, B=agree, C=neutral, D=disagree, and E=strongly disagree. The participants record their answers on a provided Scantron form using the above scale.

Data Analysis

Initial data was gathered on twenty-eight interns at the beginning of their intern semester in the fall of 1994. Fifteen of the interns fell into age category 1 (18-25 years old). Five were 26-30 years old, two were 31-35 years old, one participant was 36-40 years old, three were over 40 and two did not indicate their age. Data was later gathered from the same group at the end of their intern semester in the fall of 1994. Of the twenty-eight original members of the sample, only twenty completed the post-assessment instrument. Level of significance was set at .05. Data was analyzed on an IBM VM/CMS mainframe at East Texas State University using SPSS Release 4. A t-test for independent samples was used on the data.

Summary of Results

The data analysis indicated no significant difference among this group in their pre-test and post-test of the ETSU Computer Attitude Scale by the end of their intern semester.

Discussion

Overall, the results indicate no significant difference from the pre-test to post-test. There was a difference in the means between the pretest and posttest (2.7398 versus 2.6608), but not a significant difference. It is anticipated that a greater difference will occur when analysis is conducted over the two-semester period. It can also be conjectured that the ETSU Computer Attitude Scale is not sufficiently sensitive to measure any differences when they do occur.

We do know that interns in the field-based program do undergo changes in their beliefs. Research in the beliefs of preservice teachers about literacy and literacy learning (Linek, Sampsom, and Hughes, 1994) conducted on the same group of students indicated a change in beliefs after their first semester in the field-based program. The interns beliefs changed from being teacher-centered to more student-centered, from a perception of the child as a receiver of knowledge to the child as a constructor of knowledge, from a simplistic and linear view of teaching to a more global and complex view of teaching, and from the perception of organization and management from separate subjects to a more integrated approach. The results of this study also imply that the primary context for preservice teacher education should be in public school classrooms. Thus, if there are drastic changes in the beliefs of the interns in the field-based program, then it would be proper to posit that a change in their attitudes would also occur.

This is an ongoing study. The initial data from the first semester did not identify any changes in attitudes toward computers. However, as the students continue to work in field-based settings, and once more data are gathered from this group over a longer period of time and from a larger sample in the subsequent semesters, it is the belief of these researchers that statistically significant differences will be found.

By its very nature of being in a field-based program, instructional technology has much potential. Students have an opportunity to go beyond traditional instructional developmental activities and use technology in a real life situation. The field-based program could increase the preservice students' knowledge of instructional technology and enhance the integration of educational technologies in the schools.

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Appendix A

ETSU Computer Attitude Scale

Please record your responses on the provided Scantron form using the scale immediately below. This scale is printed at the top of each page of this survey. A=strongly agree B=agree C=neutral D=disagree E=strongly disagree

1. I do not feel threatened when others talk about computers.
2. I feel comfortable when a conversation turns to computers.
3. Generally, I would feel OK about trying a new problem on the computer.
4. I enjoy computer work.
5. Computers will improve education.
6. I think using a computer would be very hard for me.
7. I feel at ease when I am around computers.
8. If there were a computer in my classroom it would help me be a better teacher.
9. If I had the money, I would buy a computer.
10. Computers can be useful instructional aides in almost all subject areas.
11. I have a lot of self-confidence when it comes to working with computers.
12. Computers make my life enjoyable.
13. Working with a computer would make me very nervous.
14. I like learning on a computer.
15. Computers are beyond the understanding of a typical person.
16. I would feel comfortable working with a computer.
17. I'm no good with computers.
18. I will do as little work with computers as possible.
19. I would like to receive further training in computers.
20. Computers make me feel uneasy and confused.
21. Computers make me feel uncomfortable.
22. Having computers in the classroom would be fun for me.
23. I get a sinking feeling when I think of trying to use a computer.
24. I'm not the type to do well with computers.
25. I feel qualified to teach computer literacy.
26. I will use a computer as soon as possible.
27. I would like working with computers.
28. I feel aggressive and hostile toward computers.
29. I have become familiar with computers through my previous experiences.
30. I would never take a job where I had to work with computers.
31. Computers could enhance remedial instruction.
32. I would feel at ease in a computer class.
33. Computers will improve health care.
34. I do not think I could handle a computer course.
35. Computers do not scare me at all.
36. Computers can be used successfully with courses which demand creative activities.

State Technology Curriculums: A National Survey

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The rapid acceptance of computers in the public schools is a phenomenon that only a short time ago seemed an impossible task. The ratio of computers to students is currently 20 to 1, up from 125 to 1 as recently as 1983–84 (Maddux, Johnson, & Hallow, 1993). To keep pace with classroom proliferation of electronic data processing equipment, standards for computer science education have been developed by the International Society for Technology in Education. These standards have been formally adopted by the National Council for the Accreditation of Teacher Education (Tailor, Thomas, & Knezek, 1993). In 1988, in Electronic Learning's Eighth Annual Survey, it was written that 75 percent of states planned to develop new programs on technology. Obviously, there is a discrepancy between what states thought they could accomplish and what they have. Appropriate questions continue to arise on how schools are implementing computer use and whether specific guidelines and curriculums have been developed to deal with efforts to integrate technology and schools.

The North Carolina Department of Public Instruction recently adopted teacher competencies for all school personnel requiring certification. In addition, computer skills are required for all students before graduation. The general goal for teacher competencies "are to assist an educator in acquiring the knowledge and skills necessary to introduce students to the computer skills identified for all students." The student computer skills' curriculum focuses on "preparing the student to be an independent user of technology for personal and school needs" (NC Correlation Chart, 1993).

The conception of this study comes from the inspiration of the actions of the North Carolina Department of Public Instruction. The purpose of the study is to determine the current involvement of other states in their development and implementation of technology/computer skills' curriculums. This study compares state requirements toward computer literacy. If available, curriculum guides have been collected and used for this comparison. Questions such as grades covered in the curriculum, assessment of competencies, and implementation of curriculum are also explored. Comparisons among the states are made. Individual comments about desire and needs have also been collected.

Procedures

All fifty state departments and the District of Columbia have been contacted. When a contact person in the fields of curriculum development or technology was located, the previously listed information was requested. The Department of Technology Assessment in Washington, D.C. has also been contacted for information on past surveys dealing with individual state curriculums. Follow up phone calls have been made to request information which has not been sent.

Results

Information from Telephone Conversations

Nine states describe statewide curriculums in technology. Seven additional states and the District of Columbia explain that they are in the process of obtaining approval for statewide curriculums. Fifteen states do not have statewide curriculums, but instead use guidelines, models, or exemplary curriculums to help individual school districts create their own. Five states responded that there are no statewide curriculums, no guidelines for technology in their states, and no plans for such action. No response has been received from the last fifteen states.

During the telephone conversations, one of the state's representatives requested a copy of NC's curriculum guide, three states discussed their plan for increased telecommunications for education, and two states expressed the desire for creating a statewide curriculum.

Information from Documents

The titles of the seventeen state curriculum documents that have been received are: Course on Technology, Curriculum Integration Guide, Curriculum Framework, Curriculum Plan (2), Report on Technology, Computer Usage Competencies, Individual Technology Application Skills, Technology Guide K–12 (6), Planning Guide, Goals for Technology, and Educational Program Guide.

There is a wide range of information in the content of the documents. An analysis of the grades covered, specific competencies and implementation of the curriculum of each state's proposal follows. Nine states list plans and/or curriculum for grades K–12. One state covers curriculum for PreK–12. An additional three states address curriculum for middle grades through high school. One state divides computer literacy from 7th to 8th grade, business computer curriculums for 9th through 12th grades, and infusion of technology from K–12. The state that provided an individual school district's plan ranges only from 6th through 12th grade. One state divides their curriculum between computer literacy at grades 3–8 and computer education at grades 9–12. No consensus has been observed on the introduction of computer skills into the curriculum, but all states continue their curriculums through the 12th grade.

Four states have developed specific goals and educational objectives. Another state reports that they are in the process of developing specific outcomes and objectives for PreK–12 grades. One state lists a rationale and objectives, whereas another lists a rationale and requirements. Two states discuss their educational objectives in terms of Bloom's Taxonomy and higher level thinking skills. One state references their outcomes to the cognitive, psychomotor, and affective development domains. In addition, this state also codes their outcomes with regard to multicultural, gender fair, international, and disability–sensitive issues. The initial analysis was not searching for curriculum integration of specific goals and objectives but, this information is clearly displayed in some state's charters. Seven states write about integrating technology into all subject areas of the public schools. One state created a matrix of integration at all grade levels and with all subject areas. One state adopted "rules mandating learner outcomes for information technology be integrated into other curriculum areas and not taught in isolation as a stand alone subject." This state also included a discussion of integration versus relation.

Our third area of exploration in these plans is the implementation of technology into the curriculum. Nine states write about their guides, plans, or strategies for this application. One state discusses the inservice needs of teachers and the fact that not all schools have sufficient hardware and software nor adequately trained teachers. Another state lists specific strategies for dissemination, preservice, inservice, and certification functions. A plea for a cooperative effort between educators' groups, curriculum personnel, administrators and teacher training institutions is given by one state. Another state gave a 5–year plan between the state department of education and the state board of education. One state adds that they plan distance learning certification for current teachers.

Additional information noted in individual plans includes some other interesting points. One state wrote that computer literacy skills were created as early as 1984, but never implemented due to funding. These skills have been replaced with an emphasis toward technology skills. Interestingly, teacher education programs are rarely listed as a place for teaching technology skills. This concept is found in one document that lists the need for teacher education programs to effectively integrate technology into the curriculum. One state lists video skills in their technology curriculum. Two states list programming, robotics, and computer–assisted design skills. One of these states also includes hardware and software evaluation worksheets. The inclusion of keyboarding also varied as to where it was inserted into the curriculums. One state lists it from K–4th grades. One state teaches it only in 3rd grade. Another individual school district lists keyboarding skills from K–8th grades. One state lists it only in business education classes. Three states began their curriculums or plans with literature reviews of technology. One state includes societal issues and ethics as skills in their curriculums.

Funding for technology curriculums varies among states also. One state plans to create an educational technology trust fund to be administered by the department of education. The state that develops its curriculum plan with the aid of businesses included a budget request of 150 million dollars.

Discussion

Those in charge of curriculum design in states may view technology as entry skills into higher education. Through their lack of inclusion in the early grades, we can speculate that some do not see or at least do not emphasize computer technology as a means to enhance the learning process. Thus, its omission until a quantifiable test of acquired skills can be attained at the later grades.

A wide range of competencies is found among the states. Some states report no competencies are developed at this time. These may be omissions in their documents, not in their plan. Several states clearly said that they were constantly changing or currently updating for future adoptions.

It is clear from the curriculums that different states are approaching the implementation of technology into the public schools from different directions. These directions seem to be driven by different groups. One state clearly has an emphasis on higher education, most likely originating from the chair of the state's committee on technology being a leading chancellor of the state's higher education system. Second, one plan up for adoption creates a joint effort between businesses and the state department of education. We believe that this is also the result of the makeup of the committee. Third and by far the most popular model is that of a state department driven technology curriculum. From the information that we received it is unclear whether this model is driven by self initiatives or by external pressures.

The nature of the technology field is fluid and changing. This absolute cannot be underemphasized and is reflected in all aspects of the conversations, the structures, the charters and the documentation of state departments technology curriculums in this study. There is far less universal agreement on the effect or even the definition of technology than there is on any of the more fundamental and traditional aspects of education. Numerous technology curriculums cited that constant review and updating is required. Others cited politics and false starts emphasizing that the implementation of technology in the curriculum are falling far short of any consistent pattern. This study emphasizes what has been sent to us, but has for the great part overlooked states that either did not send or did not see the importance of developing a technology curriculum. It would be naive and reflects a pejorative attitude to assume that all states or even close to a majority of educators emphasize technology as a primary objective in education, let alone warranting the vast resources of energy for curricular restructuring and financial resources for technological hardware. This study is a snapshot in time and its greatest contribution will undoubtedly be as a piece in the evolutionary educational path.

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Technology in Teacher Education — Faculty Attitude, Knowledge and Use

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Teachers need to be competent users of technology and advocates of a positive attitude toward adopting technology. In order to accomplish this task, teachers must have role models - faculty in higher education (Munday, Windham, & Stamper, 1991). Adequate training for teachers has been proposed "as the most important ingredient affecting implementation of new technology" (Office of Technology Assessment, 1988, p. 17).

Observers and researchers of American higher education agree that the adoption of technology into higher education and especially in teacher education programs is not widespread (Bork, 1990; Faseyitan, 1990; Faseyitan & Hirschbuhl, 1991; Greene, 1991; Beaver, 1992). Bork (1990) and Scrogran (1989) point out that the vast majority of teachers today have little or no training in the use of new technologies. One of the reasons why technology is not widespread in teacher preparation is that the faculty members in the education departments lack expertise in the instructional use of technology (Beaver, 1992). In 1989, Bitter and Yohe reported that integration of technology into teacher education curriculum was the single most pervading issue in colleges of education relative to technology. Today, it is still a major concern.

In many classrooms today, students have demonstrated more comfort with and expertise using technology than their teachers (Office of Technology Assessment, 1988). Beginning teachers are inexperienced in using technology (American Association of Colleges for Teacher Education, 1987a; Bork, 1990), although the ability to use technology effectively is rapidly becoming a prerequisite skill for finding a teaching position (Beaver, 1992; Moursund, 1989). A resolution adopted by the Association for Supervision and Curriculum Development (1989) notes that schools use technology less than other sectors of society, even as the need for the use of technology is growing more critical. These situations need to change. Teacher preparation programs must redirect their focus on the immediate and future needs of their students in the following ways:

1. Teachers must be proficient, critical users of current educational techniques, including recognition of their limitations and future possibilities.
2. Teachers need a broad education in order to determine the applications of changes and innovations in technology from more than one perspective.
3. Teachers must be competent designers of instructional systems which will enable them to assist their students to become critical thinkers (Bitter & Yohe, 1989, p. 23).

In order for these goals to be attainable by our future teachers, these same goals need to be incorporated into the philosophy of faculty in teacher preparation.

The American Association of Colleges of Teacher Education (1987b) identified 10 critical considerations that must be recognized if educators are to receive needed information about technologies:

1. Information technology in schools is not a passing fancy.
2. Information technologies encompass a variety of equipment and applications in addition to computers.

3. Information technology is a critical resource in the effective delivery of instruction.
4. Information technologies are a means rather than an end in the educational process.
5. The use of information technologies is an important component in the training of all professional educators.
6. Specialists in educational technologies are needed for both school and nonschool settings.
7. The leadership of deans is critical to the successfulimplementation of information technologies.
8. SCDEs (State Colleges and Departments of Education) must exert leadership in research and development activities related to educational technologies.
9. Colleges of education should play a major role in efforts to achieve equity in the access to new technologies.
10. Colleges of education administration and facultyhave the responsibility to inform themselves about the new products which have educational implications. (pp. 25-27).

If teachers are expected to demonstrate effective teaching practices and prepare students for the future, then their mentors, faculty in teacher preparation programs, must also be prepared to meet the same expectations.

Research is needed to monitor, report and evaluate the progress of the inclusion of technology in teacher education programs. It is also important to investigate factors that may be helping or hindering the planning and adoption of technology by faculty members in the preparation of teachers. The literature on computer use in higher education was not conclusive regarding what personal attributes of faculty were related to computer use. Besides computers, the present study included other important technologies that are necessary for the preparation of future teachers. Therefore, the present study investigated the relationship between gender, rank and prior experience of the university/college faculty and attitude toward technology, knowledge about technology and use of technology. Results could provide information that would describe how groups of faculty members might differ in their need for training or retraining in certain technologies. Results could also provide information indicating trends concerning particular personal attributes that distinguish faculty members who are knowledgeable users with positive attitudes toward technology from those who require training. In turn, teacher educators could provide important, high-quality exposure to technology to preservice teachers and inservice teachers.

Method

The *Teacher Educator Technology Survey* was developed to investigate the relationship between the factors gender, rank and prior experience and the following response variables: attitude toward technology, knowledge about technology and use of technology. After the pilot instrument was administered to 100 teacher educators, a revised survey was administered to 733 teacher educators in colleges of education throughout Pennsylvania. The sample consisted of both male and female faculty and focused on the following departments: curriculum and instruction, early childhood, elementary, secondary, special education. All academic ranks of faculty were represented: instructor, assistant professor, associate professor and professor.

Cronbach coefficient alpha was used to assess reliability in the sense of internal consistency for each of the subscales: knowledge about technology, use of technology, attitude toward technology, belief that access is useful, access to technology, training at the university and technology experience. Results of the Cronbach coefficient alpha ranged from .8198 to .8670 on the subscales.

Data Analysis

Descriptive data were collected about the faculty and their university/college. Responses to the Likert-type questions on the subscales: knowledge about technology, use of technology, and attitude toward technology were summed to arrive at a total score for each subject's level of knowledge about technology, level of use of technology, and level of attitude toward technology. The data were analyzed as an interaction model. Each respondent's score on any factor was assumed to be represented by a linear combination of three main effects (gender, rank, prior experience), three two-way interaction effects (gender by rank, gender by prior experience, rank by prior experience), and one three-way interaction (gender by rank by prior experience). Multivariate analysis of variance (MANOVA) was used to test for main and interaction effects Since MANOVA simultaneously tests for significance among all criterion measures, this process protects against alpha inflation or Type I error that exceeds the nominal level of .05 for the entire study. Univariate analyses then followed the MANOVAS.

Results: Descriptive Statistics

A total of 421 (57.44%) useable surveys were returned out of 733 mailed. The majority of respondents were full-time faculty members with a doctorate degree and more than 20 years experience from large teacher eduction programs. Table 1 presents the demographics of the respondents.

Results: MANOVA

The response variables attitude toward, knowledge about and use of technology were analyzed by means of a multivariate analysis of variance (MANOVA) to detect differences between gender, rank or prior experience in education and their interactions. The MANOVA revealed no significant main effects or two-way interaction effects. It did reveal a significant effect ($p < .05$) for the three-way interaction. However, none of the univariate analyses of variances (ANOVA) on attitude toward, knowledge about or use of technology separately detected such differences due to interaction of gender by rank by prior experience.

Table 1. Respondent Characteristics

	N	%
Gender		
Male	250	59
Female	171	41
Status		
Full-time	395	94
Part-time	26	06
Rank		
Instructor	29	07
Asst. Prof.	150	36
Associate	122	29
Professor	111	26
Other	09	03
Prior Experience		
1-5 Years	8	02
6-10 Years	22	05
11-15 Years	48	11
16-20 Years	79	18
More than 20 Yrs	264	63
Degree		
Masters	97	23
Doctorate	324	77
Major Area of Emphasis		
Curriculum & Inst.	65	15
Early Childhood	19	05
Elementary	96	23
Secondary	75	18
Special Education	52	12
Other	114	27
Age		
20-30	6	01
31-40	69	16
41-50	172	41
51-60	148	35
Over 60	26	06

Discussion

This study found no reason to provide differential training for the groups investigated. No significant differences were found to exist between males and females on the response variables: attitude toward technology, knowledge about technology and use of technology. Some possible explanations for this follow. First, this phenomenon is similar to what happened with computers when they were first introduced as an educational tool. Male students and teachers tended to use computers more frequently than females did (Burke, 1986; Koohang, 1987). However, as demonstrated by the present study and other studies (Faseyitan & Hirschbuhl, 1991; Fuller, 1986; and Milet, 1991), women professors in higher education eventually caught up with their male counterparts and now there is no significant difference between males and females in their use of computers and other related technologies. Other studies also reported little or no difference between male and female teachers in their attitude toward technology (Fary, 1988; Grasty, 1985; Smith, 1985). Second, due to early uses of computers for applications such as word processing, data entry or playing games, women today show less apprehension about using computers for other more sophisticated purposes than they did in earlier studies. Third, women who have chosen a profession in higher education preparing teachers are aware of the importance of technology not only in education but in their students' future careers. The fourth possible explanation involves the phenomenon, "restriction in range" (Borg and Gall, 1983). The present study involved a population, males and females, restricted in their range of expertise: faculty members in teacher education. They are adults that have attained graduate degrees and embarked on their chosen profession, thus eliminating those adults with lower levels of interest, aptitude and motivation. Such a situation produces a phenomenon known as "restriction in range," which results in a great decrease in the power of a statistical procedure to detect differences among groups. The groups are so similar to begin with, it is difficult to apportion those differences to various sources. Thus, the present study could be taken as evidence that the gender gap is disappearing, at least within this restricted population.

In this study, no significant differences were found to exist between ranks on the response variables attitude toward technology, knowledge about technology or use of technology. Similar to this study, rank was not found to be significant in relation to adoption (use) of computers in higher education (Faseyitan & Hirschbuhl, 1991). Other studies involving faculty supported rank as a consistent predictor of the use of computers (Bauschka, 1989; McCord, 1984; Milet, 1991) and of the attitude toward computers (McCord, 1984). The present study supported the findings of Faseyitan & Hirschbuhl's (1991) study. Rank was not found to be significant in relation to adoption (use) of computers and other technologies in higher education.

The MANOVA procedure revealed no significant relationship between prior experience and the group of response variables. The present study supported previous studies involving teachers (Burke, 1986; Dupagne & Krendle, 1992; Grasty, 1985; Martin & Lundstrom, 1988; Smith, 1985) and those studies involving faculty (Fuller, 1986). Scott (1986) reported the contrary finding. Teaching experience was one of several variables that differentiated users of computers from non-users among college faculty.

In addition, there were no significant differences in attitude toward, knowledge about or use of technology that were due to the two-way interactions of gender and the rank, gender and prior experience or rank and prior experience. The MANOVA analysis in which the response variables (A, K & U) were tested as a whole to see if they showed differences that were due to gender by rank by prior experience interaction, the initial multivariate test was significant, implying that there were differences that were due to the three-way interaction. However, none of the univariate ANOVAs were able to detect any significant effect on any single response variable by the three-way interaction. In situations such as this, the multivariate procedure is simply more powerful. Therefore, future researchers may wish to take this significant multivariate result as a signal to conduct further research on the three-way interaction by means of a more powerful design than the one used in the present study.

Analyses of additional data revealed that faculty members reported accessibility to technology as helpful. Results indicated average accessibility to technology at the faculty members' universities. However, faculty members tended to report little or no formal training in many types of technology available at their institutions. A majority of respondents predicted that in the future, technology would be indispensable to them personally as instructors in teacher education, and would help a great deal or be indispensable to the profession overall.

The survey also elicited faculty members' assessment of the sources of their knowledge about technology. Results indicated that the majority of faculty members were self-taught or received informal help from others. Men tended to report greater percent of their knowledge as self-taught than did women. Women reported greater percent of knowledge as help from others than did men.

Recommendations

A trend toward greater usage of technology is becoming apparent in the field of education. To continue this trend, it is recommended that teacher educators and technology departments share their accomplishments by conducting research to assess the effectiveness of technology in their instruction and communication systems, thereby sharing the results to inform other teacher educators of the advantages and the disadvantages of using technology in training faculty and preservice teachers.

It is recommended that a procedure be developed to collect information on the types of programs, practices and courses involving technology that are presently enhancing skills of the faculty. Using a similar procedure, collect information on the types of programs, practices and courses involving technology that are presently enhancing skills of the preservice teachers. As a result of the two previous recommendations, compile a directory of the programs, practices and courses involving technology. Disseminate the directory via technology directly to teacher education programs or to professional organizations involved in teacher education to encourage communication and adoption of such technology advancements. This is one way that teacher educators can monitor developments in technology in order to adapt and model effective practices so their students can perform effectively in a technology-based environment.

In planning future training for faculty in teacher education, the results of the present study indicated that it is not necessary to differentiate groups according to personal attributes: gender, rank, prior experience. To see if grouping is necessary, other types of variables need to be investigated, e.g., institutional variables. It is recommended that attitude toward, knowledge about and use of technology continue to be used as variables in future studies involving teacher education in order to continually investigate future trends and to monitor the needs of teacher educators.

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Faculty Images of Technology Integration in Teacher Education

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For most teacher training programs, the main goal is to train their students to become effective teachers using whatever tools necessary to accomplish this task. With the advent of the computer age, teacher training institutions began to look to this new technology and to consider ways in which various aspects of educational technology could be integrated into their curriculum. Technology as a whole has not met many of the high expectations first placed upon it. However, these training programs are beginning to understand how technology can be used to train students to become effective and efficient in the classroom. Researchers such as Nelson, Andris and Keefe (1990) and Troutman and White (1991) have all reported that a computer-intensive teacher training program can better prepare teachers to meet the learning needs of their students. To achieve this end, several researchers have reported that simply providing computers in the educational setting is not enough. Effective implementation will be strongly influenced by the beliefs of the teacher about the role technology can play in the instructional setting (Niederhauser and Stoddart, 1994).

Review of Current Literature

Current research supports the idea that teachers teach in a manner reflective of their own learning experiences (Niederhauser and Stoddart, 1994). Because the implementation of computer technology into instructional situations is a recent phenomenon, most teachers in public education as well as higher education have not had an opportunity for technologically directed learning experiences. Their knowledge of computer usage and implementation has been acquired primarily through self-taught situations or continuing education experiences.

In their study of student teachers' perceptions of technology in the schools, Kraus, Hoffman, Oughton, and Rosenbluth (1994) found that most student teachers' prior computer experiences consisted of word processing and computer games. The research team found that these experiences were strongly correlated with positive attitudes toward use of computers in the classroom. Huang (1994) reports that teacher education faculty serve as role models and their use of and attitudes toward technology in the classroom strongly influence the implementation of technology by student teachers. In addition, in a study of first year teachers by Handler (1993) it was reported that while technology courses taken during teacher training provided knowledge of computer usage, there was a strong need for modeling by teacher education faculty to provide the integration component.

It appears that positive attitudes and a strong modeling program regarding computer technology are critical elements for teacher education faculty. To effectively prepare teachers for the current technological revolution in education, teacher education faculty must be proficient in the integration process.

Purpose and Design of the Study

This study used qualitative research methodology to examine the impact of experiences with technology prior to and during a current semester of education courses. The study examined teachers' attitudes toward and knowledge of the use of instructional technology. The 10 teacher education unit faculty who participated taught a wide variety of courses at a small teacher education institution. The purpose of the study was to describe the technological experiences of faculty members, their past experiences in technology, both personal (as applied to work and home) and previous classroom experiences as well as their current efforts to integrate technology into their courses. The design was pre/post with qualitative data—interviews—to examine the backgrounds, attitudes, methods of implementation, and their suggestions concerning technology in their current teaching situation. A division-wide focus on the integration of technology can be based upon the findings of this research utilizing a recently acquired multi-media lab.

The 10 teacher education unit faculty members represented a variety of content area backgrounds — two English/Language Arts, two Elementary Education, one Science/Math, three Special Education, and two Foundations of Education. The participants were interviewed using a semi-structured interview schedule. The interviews were conducted during the first and last weeks of the semester.

Results

Data from the transcribed interviews were segmented into idea units and categorized using a phenomenological approach (Hycner, 1985). The categories identified through our analysis were (1) previous technological experiences, (2) perceptions of the role of instructional technology, (3) knowledge of instructional technology, and (4) perceived values of instructional technology.

Previous technological experiences

The teaching experiences of the 10 participates ranged from five years to twenty-seven years with each having some previous public school experience. The previous technological experiences varied from very limited exposure with word processing "the only real vision I have is creating the lesson plan on the word processing program" to some experiences with computer programming for classroom activities "I had the first microcomputer in a classroom in the state of West Virginia in a seventh grade math class in 1978—it was a Commodore and I programmed basic programs for the students."

Perceptions of the role of instructional technology

The teacher educators' perceptions of technology reflected two ideas regarding the importance of technology in the classroom.

Eight of the ten participates indicated a need to strengthen the preservice teacher program by integrating technology most commonly used in the service area public schools "students need to become more familiar with the software that is out there and then they can plug it into their lesson plans," "We need to teach students getting ready to do student teaching how to use computers to manage — such as grade book. The college instructors need to model this integration for our students." Two participates felt that instructional technology should be used judiciously rather then attempting to use it exclusively "I am more experiential based, I want students to do things."

Knowledge of instructional technology

All ten participants expressed a need for assistance in choosing software, integrating technology in their classrooms, and appropriate modeling of instructional technology "knowing computers is not the same as knowing how to integrate," "teachers need to know what other avenues of technology are available besides overheads," "I need some outside help to learn how to use the lab," "I would like to be able to implement some of the software that is out there in children's literature and other literature classes such as Shakespeare."

Perceived values of instructional technology

A final theme that emerged from the data was the teacher educators' perceived usefulness of technology. All ten participants clearly identified positive aspects of integrated technology "Students will see that technology can be integrated and they will become comfortable with it. If they are comfortable, they will open up and try new things," "I have never had a computer class, but I have taught myself and learned from others...I want to know everything there is to know about computers," "Students will gain at all levels at all times (through the use of technology)," "I want my students to learn what an opportunity computer proficiency can be to connect with the world in finding out new information."

Conclusion

As we begin to examine the experiences, knowledge and perceptions of these teacher education unit faculty members, some images begin to emerge. Even though the experiences of these 10 participants varied from limited word processing to programming, they each displayed a positive attitude towards the integration of technology into the teacher education program. In addition, each felt the need to serve as a positive role model in this regard. Faced with this task, each indicated the need for assistance with the implementation phase as well as guidance in selecting appropriate technology components.

The preliminary findings suggest that these teacher educators have approached implementation of technology in a positive manner. They have taken the initiative in developing and expanding their knowledge base in the area of relevant instructional materials dealing with instructional technology.

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Educational Technology: School Administrators Voice What Teacher Candidates Need to Know

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At Northern Michigan University, as elsewhere, we are under fire from the state legislature, the State Department of Education, and the National Council of Accreditation for Teacher Education (NCATE) to prepare our teachers for the use of technology in their future classrooms. Guidelines abound from these and other agencies as to the goals of such preparation. We felt a need to hear from the front lines, specifically those using our student teachers and hiring our graduates. A survey was developed and mailed to all district superintendents and principals in the Upper Peninsula of Michigan.

Follow-up telephone interviews and teleconferences are being planned to refine and gather additional data. The results of the survey[1] will be presented along with implications for departments of teacher education.

Questions

What do school administrators (superintendents and principals) expect of teacher candidates in the way of technology knowledge and skills? This question was posed to school administrators across the Upper Peninsula of Michigan, including large and small districts, wealthy and poor districts.

Specifically, the following questions were asked of the administrators:

1) How are teacher candidates evaluated during the application, interviewing, and hiring process in relation to their technology knowledge and skills?
2) How important, in the overall evaluation of a prospective teacher, is their knowledge and skills relating to technology?
3) Specifically, what type and level of technology training do you expect from prospective teachers?
4) How can colleges and universities better prepare teacher candidates for technology in the classroom?
5) And finally, what types of technology are readily available in your district for teachers to utilize?

Further, the administrators were asked to provide any additional comments in regard to student teachers and/or teacher candidates and their preparation for the use of educational technologies.

Pilot Study

On September 22, 1994 the Council for Preservice Technology (CPT)[2] held a panel discussion of K-12 administrators in Lansing, Michigan to focus on larger questions. This panel and their responses led to the development of a study of the Upper Peninsula administrators by the author.

The four panel members at the CPT meeting were: John Armstrong, Superintendent of L'Anse Creuse Public Schools; Dr. Keith Voight, Assistant Superintendent of Macomb Intermediate School District; Sharon Stream, English and Special Education Area Coordinator for Plymouth Salem High School; and Jim Haskins, Rockford High School Principal. Each question will be discussed separately.

Question 1

First, how are teacher candidates evaluated during the application, interviewing, and hiring process in relation to their technology skills? A variety of answers were given to this question as might be expected due to differing levels of technology applications in each of the districts represented. The answers highlight the varying importance of technological skills in the hiring process.

One school uses a survey for prospective teachers. It asks them about such things as exposure or prior experience with various technologies, i.e. CD-ROM, computers, cable in the classroom, laserdiscs, tape recorders, VCRs, camcorders, network repair, on-line services, and projection devices. In addition questions ask the candidate to describe a lesson incorporating appropriate technology into a lesson. Others asked how technology contributes to the effectiveness of a lesson . The questionnaire also contained with the following questions: What technology resources would you expect to have available in your classroom? What type of technology staff development do you feel you need? How do you see students using technology in your classroom or as part of their instructional curriculum? What are your concerns about the use of technology in the classroom?

Another administrator emphasized that future teachers should demonstrate overall technology skills, incorporate technology into lesson plans, be flexible learners, and be interested in cooperative learning environments and an interdisciplinary curriculum, as well as be familiar with accessing telecommunications and researching topics through the global community. Future teachers are expected to be comfortable with word processing, databases, and spreadsheets. Specific hardware technologies future teachers need to be comfortable with included CD-ROMs, laserdiscs, video camcorders, and still video or zapshot cameras. In addition, it is expected that future teachers will be able to follow instructions to connect a digital visualizer, a still video camera, a laser disc player, a CD-ROM player, and a modem to a microcomputer workstation.

General technology skills desired of future teachers by all districts were deemed important. Knowing the potential uses that computers hold for the curriculum, being comfortable with managing multiple students with computers, and being able to read manuals and instructions for 'how-to's' are all considered necessary skills. The ability to run programs in both IBM (DOS and Windows) and Mac environments is considered essential. Likewise knowing the potentials of video in the curriculum and how to incorporate other technologies, i.e. CD-ROM, are regarded as valuable. Finally, being able to hook up a computer and managing the visual display of a computer in front of a class through LCD panels, large monitors, or video projectors are definite technology skill pluses.

Question 2

In the overall evaluation of a prospective teacher, how important is their knowledge and skills relating to technology? Again, the responses to this question varied considerably by district. It was emphasized by all the administrators that technology knowledge and skills are definitely a consideration along with other skills relating to restructuring schools. In fact, it was specifically stated that the use of technology absolutely necessitated restructuring. One administrator highlighted the idea that teachers need to be mass communicators and gatekeepers of information and that the basics of good teaching without technology should not be languished. This concern was seconded by another administrator who identified future teachers need to know how to teach differently, understand collaborative and authentic learning, and be comfortable with restructuring and change as of primary importance.

Overall, the comments to this question can generally be summarized by the statement of one administrator that the most important characteristic for a future teacher is someone who really wants to teach children, along with good work ethics, people skills, extensive content knowledge, and finally creative instructional strategies including technology skills.

Question 3

Specifically, what type and level of technology training do you expect from prospective teachers? The overall response to this question underscored the need for future teachers to be technologically aware rather than proficient. As mentioned by one administrator, new teachers should be conversant and knowledgeable about technological tools, but it is understood that it is not possible for new teachers to know it all. To further emphasize this point, most of the administrators spoke of the need for continuing training in the use of educational technologies, not only for their new teachers, but for experienced teachers as well. One district offered voluntary after school technology oriented workshops as well as several half-day required released time inservices to the teachers in the district to acquaint, maintain, and improve technology knowledge and skills. Another district offered summer workshops to all of its teachers. The use of school improvement funds by one district for teacher technology training indicates the level of concern the topic holds for administrators. A consensus that new teachers must be lifelong learners not afraid of change, was evident and that 'on the job' training for new teachers, as well as current teachers, is a must.

Question 4

How can colleges and universities better prepare teacher candidates for technology in the classroom? Although this question received the least amount of time for discussion, several issues were identified as being of importance in preparing future teachers for the use of technology. Knowledge of computer software evaluation was a concern of one administrator. Exposure to other and the newer technologies, i.e. high density TV, virtual reality, voice recognition, cellular technology, adaptive technologies for special needs students, optical media, integrated learning systems, distributed learning systems, cable and satellite access, and distance learning were also mentioned as relevant. These are in addition to expectations of general computer and technology use as outlined in the previous questions.

Another expressed concern was future teachers not just learn 'how to' create Hypercard stacks for their own use, but that teachers learn how to incorporate the creation of stacks into the curriculum so students experience the construction of knowledge that comes from designing and developing their own stacks. This idea can be transferred to other types of technological use, i.e. word processors, databases, spreadsheets, graphics programs, etc. In other words, teachers need to know how to use these tools for their own use but also how to encourage and support student use of the tools as well.

Finally, it is extremely important that colleges and universities model how to teach with technology in the content areas. Research has shown that teachers most often teach as they have been taught. Without appropriate modeling of integration of technology into coursework, future teachers cannot be expected to develop desired skills. Specifically, in regard to student teachers, a different (better?) method needs to be developed to match student teachers with model coordinating teachers, especially in regards to the integration and use of educational technologies. Colleges and universities need to work closely with K-12 schools to ensure adequate placements in order for maximum learning and practice to occur during the student teaching period.

Question 5

And finally, what types of technology are readily available in your district for teachers to use? As evidenced by the responses to the preceding questions, a variety of technologies are available to the teachers in these districts. Computers mentioned included Apple IIs, IBMs and compatibles, and Macintoshes. The specific platform depended on the district. Many districts now support the use of more than one configuration. Included in the computer configuration were dot-matrix, ink-jet, and/or laser printers. In addition, these districts reported the general availability of CD-ROM players, videodisc players, still digital cameras, video camcorders, computer projection devices, and modems. Local area networks are common especially in computer labs. It appears that in many cases, the availability of educational technologies in Michigan's K-12 schools is above and beyond that found in the colleges and departments of education at the university level.

Further, the administrators were asked to provide any additional comments in regard to student teachers and/or teacher candidates and their preparation for use of educational technologies. Referring to the continual need for technological training on the part of all teachers in their districts, these administrators recommended the use of students who were technologically knowledgeable as aides to teachers as an effective method of supporting teacher learning. Likewise, these administrators supported the concept of technicians and technology coordinators/directors as essential to the successful implementation of technology in their districts.

Implications to Departments of Teacher Education

The answers to the questions posed of K-12 school administrators regarding student teacher and teacher candidates' knowledge and skills in the use of educational technologies supports the goals and objectives of Michigan's State Technology Plan 1992-1997 and student teaching mandates[3] and NCATE's technology guidelines. It is apparent from all sources, governing agencies and hiring agencies, that departments of teacher education and colleges of education must address educational technology issues more fully than presently being done. Only by preparing our students in the appropriate uses of educational technologies can we expect them to become users of these tools. Without future teachers technological knowledge and skills more fully developed, we cannot expect them to provide the types of exciting, challenging, and rewarding experiences to their students that we know are essential to foster deeper educational benefits.

Notes

1 This paper reports on the pilot study only. Results of the questionnaire of the Upper Peninsula administrators are not yet available. The full paper with a report of all data collected is available from the author.

2 The Council for Preservice Technology (CPT) represents Michigan's educational institutions, agencies, and individuals interested in technology for preservice teachers. The CPT, founded in 1991 as a professional organization, continues the work of the Michigan Department of Education's Preservice Technology Task Force. The Council has both institutional and individual members, and is governed by an eight member Board of Advisors. The CPT strives to: promote the use of instructional technology in the education of preservice teachers through sharing information, study, experimentation, and demonstration, and provide leadership in preservice technology education to the teacher education units of Michigan colleges and universities, the Michigan Department of Education, and other professional organizations. Interested persons can contact the author for further information.

3 See the article entitled "One Teacher Education Program's Answer to Technology Integration" by this author in this volume for a listing of Michigan's State Technology Plan 1192-1997 and mandates for student teachers.

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Are We Meeting Students' Needs in Instructional Technology?: Student Perceptions

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How do we know if our technology training programs in higher educational institutions are effective in meeting our students' present and future technology needs? What course aspects are considered more and less valuable to students? What changes are needed to better meet the present and future technology needs of students in their areas of interest? These were the major research questions that directed the investigation.

The rapid pace of technological change taking place in our society and within our school systems has made it difficult for practitioners and teachers of tomorrow to keep up with the latest developments. Teachers are expected to be technology leaders, model the appropriate use of the more traditional types of technology and the new and emerging types of technology, and effectively integrate a wide variety of technology into the curriculum (Brownell & Brownell, 94; Mc Kenzie, 94). Unfortunately, many practitioners and graduates from higher educational institutions are still not as technologically prepared as the job demands. Oftentimes on the job training in the schools is necessary to update teachers' technology skills.

Teacher training institutions are being challenged to accomplish these established technology expectations. Technology training programs must be based on the current technology needs in the schools, and the availability of technology in the school systems. They must contain hands-on learning opportunities for students to experiment with and learn how to use the various types of technology. In addition, teacher trainers must be able to demonstrate effective technological use while delivering instruction so that pre-service and in-service students are able to observe technology-based instruction first hand (Cashman & McCraw, 94; McKenzie & Mims, 94; Staudt, 94).

The Instructional Technology classes that were offered consisted of carefully selected course content, production, and equipment operation skills. A wide variety of technology resources and data were used to fine tune the everchanging course. This included formative and summative assessments from present and previous students, needs assessment data from practitioners and teacher trainers in the School of Education, expert opinions from technology trainers and colleagues, and a review of the literature on timely technology training practices. The resultant course included the course components:

Course Content

- Communications theory
- Copyright policies and procedures
- Design principles and instructional materials
- Distance education
- Information retrieval techniques (CD-ROM, ERIC, Internet, X-Press X-Change)
- Instructional design principles and the teaching learning process
- Instructional videography
- Laserdisc technology
- Media integration in the curriculum (audiotapes, CD-ROM, computers, displays, laserdiscs, multimedia, photography, videography)

- Media safety practices and school regulations
- Overhead transparency production techniques (hand generated, computer generated)
- Selection and evaluation of media hardward and software
- Photography
- Visual literacy

Producing Instructional Media
- Audiotape recordings (CD, cassette, reel to reel)
- Displays (bulletin board, windsock)
- Lettering techniques (Ellison, computer generated, hand generated, pressure sensitive)
- Overhead transparencies (direct & indirect production)
- Photographic prints, slides, and photosketching
- Unedited videotape production

Equipment Operation Skills
- CD-ROM and ERIC on CD-ROM
- Computers (wordprocessing, graphic programs for overhead production)
- Computer telecommunications (e-mail, Internet, X-Press X-Change)
- Copystand work
- Laserdisc technology
- Multimedia (Linkway, Hypercard)
- Photography camera
- Slide and slidetape projectors
- Video camcorder

Required Class Activities
- demonstrate effective equipment operation skills
- design and produce an instructional transparency utilizing a technique learned in class (computer generated transparency, framed transparency, acetate transparency)
- select and evaluate instructional materials that can be used with students in your field
- use ERIC CD-ROM to select an article from one of the listed areas (the use of media with students with special needs, use of media in global education, an innovative way of using emerging types of technology, the school library media specialist in a K-12 school) and critique the article utilizin wordprocessing program
- select a videodisc of interest , map it out for instructional purposes, summarize the contents, and critique the disc
- complete selected optical class projects from a listing of possibilities in Area A and Area B
- two class exams (midterm and final)

(Area A)
-evaluation of a CD-ROM program
-selection and critique of a media reading
-evaluation of a computer program
-development of a bibliography of books
-development of a listing of videodiscs
-design and production of an instructional videotape
-development of a photosketch
-design a video or slidetape script
-develop instructional slides or photographs.

(Area B)
-use the on-line catalog to find two children's books in an area of interest
-prepare a 5 minute instructional audiotape
-design a rough layout of a bulletin board
-enlarge a visual with an opaque projector
-design and develop a display
-design and develop an educational game
-create a learning center
-create a book for use in the classroom

Methodology

To assess the content and class activities in the Instructional Technology classes at West Georgia College (MED 4/601), offered to both undergraduate and graduate students, the investigators designed and administered a survey to two classes. One class was delivered spring quarter and the other class was offered during the summer quarter of 1994. The survey asked students to provide data in three general areas: (1) student demographics; (2) the degree of importance of the selected course activities and content; and (3) the value of the present course structure.

The last day of class students were asked to reflect back on their course experiences and respond to the survey by assessing the overall nature of the course they had just completed. They were informed that their responses would be kept anonymous and that the data would be used for program improvement purposes.

The survey consisted of three parts and used both closed and open-ended questions. Part one utilized closed-ended demographic questions that asked participants to circle responses that identified the following factors: class they had enrolled in, age, gender, and major. The second part of the questionnaire also used closed-ended questions. Students were required to select a number from 1 to 5 indicating the degree of importance of course variables in three areas: media production skills presented in class, media operation skills, and the course content that was delivered in instructional technology. A five represented the variable was very important to the student while a one indicated the variable was of no importance. The last section of the survey, section three, asked students to respond to three open-ended questions: (1) what aspects of the course were the most valuable to you? (2) what aspects of the course should be deleted? and (3) what should be added to the course to make it more effective?

Analysis

Responses to each of the demographic questions were tallied and then converted into percentages. This data provided an overview of the types of students who had enrolled in the classes. For the closed-ended questions in part two of the survey, mean scores were computed and then rank ordered from the highest to the lowest variables in each of the three areas. The responses to the open-ended questions in section three were content analyzed by the investigators. The interrater reliability that was conducted between the two raters supported the study's findings.

Findings

All of the 59 students surveyed completed the questionnaire. The majority of the students were undergraduates (72.9%), between the ages of 18-22 years old (36.2%), female (88.1%), and majoring in Early Childhood Education (50.9%). The class profile is shown in Table 1.

Table 1. Student Demographics in MED 4/601 Instructional Technology Classes at WGC

Category	N	%
Course enrolled in:		
MED 401	43*	72.9
MED 601	16	27.1
Age		
18-22 years	21*	36.2
23-30 years	20	34.5
31-40 years	10	17.2
41-above	7	12.1
Gender		
Female	52*	88.1
Male	7	11.9
Major		
Early Childhood Education	30*	50.9
Media Education	8	13.6
Middle Grades Education	10	16.9
Special Education	9	15.3
Other	2	3.4

Note: *= highest rating

All of the production skills covered in the class were viewed by the students as important to their professional development, especially learning how to design effective overhead transparencies and using a variety of lettering techniques for instructional purposes. As shown in Table 2, the scores for the various production skills ranged from 4.42 to 3.78.

Students reported that all of the media equipment operation skills covered in class were important. The mean scores ranged from 4.78 to 3.48. The types of media that were viewed as the most important were predominantly the new and emerging types of technologies being found in the classroom. Table 3 summarizes the students' responses.

According to students' perceptions, all of the course content that had been delivered was viewed as important. The mean scores for the fourteen content areas ranged from 4.59 to 3.83. It was interesting to note that all but two of the fourteen content areas received a 4.0 or above importance rating. Only the areas of photography and distance learning received mean scores below a 4.0. Four content areas received ratings above a 4.5. These are extremely important content areas for students' present and future technology preparation. These areas dealt with information on how to: retrieve information, integrate media into the school's curriculum, provide a safe media environment in the school, and design and produce effective overhead transparencies for classroom instruction. Table 4 shows the overall course findings.

Table 2. The Degree of Importance of Media Production Skills Presented in Class (In Rank Order of Importance)

Rank	Category	Mean	S.D.
1	Designing & producing effective overhead transparencies	4.42	.72
2	Utilizing lettering techniques during instruction	3.97	.96
3	Developing photo. prints	3.88	1.07
4	Developing audiotp, recd.	3.85	.92
5	Developing unedited videotp.	3.83	.97
6	Designing and producing classroom displays	3.70	1.04
7	Developing photo slides	3.78	.85

Table 3. The Degree of Importance of Equipment Operation Skills - In Rank Order

Rank	Equipment	Mean	S.D.
1	CD-ROM	4.78	.56
2	Computers	4.63	.72
3	ERIC on CD-ROM	4.61	.70
4	Laserdiscs	4.51	.82
5	Video camcorders	4.34	.81
6	E-mail, Internet	4.20	.92
7	Multimedia	4.17	.90
8	X-Press X-Change	4.03	.90
9	Slide and slidetape projectors	3.86	.99
10	Photography cameras	3.83	.92
11	Copystand	3.48	1.10

Responses to the open-ended questions in section 3 of the questionnaire were not as extensive. Frequency ratings varied from 20 responses to 1 response. Only those student perceptions that had more than two resonse are reported in the table below. Students were more outspoken in reporting their opinions on what was considered to be the most valuable course aspect as opposed to course aspects to be deleted. Being introduced to the various types of the new technology was reported as beneficial to students. Table 5 below summarizes the respondents' statements to the open ended questions.

Table 4. Degree of Importance of the Instructional Technology Course Content - In Rank Order

Rank	Content	Mean	S.D.
1	Information retrieval	4.59	.59
2	Media/technology applications in the curric.	4.58	.70
3	Media/technology safety	4.58	.62
4	Overhead transparency production techniques	4.58	.62
5	Copyright law	4.54	.73
6	Laserdisc technology	4.46	.93
7	Selection and evaluation of media	4.46	.65
8	Visual literacy	4.34	.96
9	Instructional videography	4.29	.83
10	Instructional design principles	4.24	.88
11	Communications process & learning	4.24	.81
12	Design principles	4.17	.87
13	Photography	3.95	.95
14	Distance learning	3.83	1.02

Table 5. Course Structure Observations of Instructional Technology Students

Statement	N
What aspects of the course were the most valuable to you?	
1 Learning how to use CD-ROM	20
2 Being introduced to new technology	18
3 Learning about laserdisc technology	15
4 Learning about computers and the various software programs	14
5 Learning production skills such as how to make overhead transparencies	8
6 Being shown different applications with the new types of technology	7
7 Being introduced to electronic communication systems (e-mail, Internet)	6
8 Having hands-on learning experiences with the different types of technologies	9
9 Learning how to videotape	5
10 Being introduced to photosketching	5
11 Learning about copyright laws and instructional materials	3
12 Learning how to use the copystand for photographic purposes	2
What aspects of the course should be deleted?	
1 Instruction on some of the older types of technology	11
2 Nothing. The course was fine as it wass delivered	8
3 Reduce the number of required class projects	3
4 Instruction on photography	2
5 The trip to the off-campus state-of-the-art media center	2
What should be added to the course to make it more effective?	
1 Nothing. The course was effective as it was delivered	8
2 Provide more of an emphasis on computers	7
3 Provide more hands-on learning activities in class	4
4 Place more of an emphasis on the new and emerging types of technololgies	3
5 Provide hands-on experiences for students using e-mail and Internet	3
6 Make sure this technology course is a requirement for juniors so that students are more aware of technology before going into student teaching	3

Implications and Restructuring

The process of designing and delivering effective technology training to teachers is an ongoing process. Based on student perceptions of those who had just completed the course, the present study found the current program relatively successful in meeting students' technological needs. These findings are especially meaningful in that the classes that were surveyed were a direct result of previous needs assessment and evaluative measures of this nature.

The needs assessment instrument, administered after the written final exam in the course, was found to be an effective way of collecting evaluative information on the nature of the course and needed revisions. The investigators plan to continue using this technique to serve as a check on the appropriateness of the technology content and activities for future and practicing teachers.

A continued assessment finding across this and past technology surveys has been that students express a need for more of an emphasis on computers in the classroom. As a result of this feedback and the increased importance of some selected computer course experiences for teachers, the investigators plan to make the following additions:

1. hands-on experiences in e-mail and Internet for all students,
2. course content and hands-on experiences in PowerPoint presentation graphics for the production of overhead transparencies, and
3. more required student reviews and critiques of the newer technologies such as CD-ROM programs, computer programs, and laserdiscs and their use in K-12 schools in their area of interest, and
4. more class time for students to interact with the computers and learn more of the available wordprocessing and graphic programs.

Less of an emphasis will be placed on the more traditional types of technology. Instruction on displays, audiotapes, opaque projectors, and filmstrips will be eliminated, except where requested by students. Tutorials will be made available to students who wish to individually review and or acquaint themselves with these technologies.

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Teacher Education Students' Attitudes Toward Educational Computing

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In recent years, one of the greatest challenges in teacher education has been trying to effectively integrate technology within teacher preparation (Barron & Goldman, 1994). Many educational organizations have incorporated instructional technology into their professional standards (Abramson, 1993). The National Council for Accreditation of Teacher Education (NCATE, 1993), for example, proposed that pedagogical studies of teachers need to include knowledge and appropriate experiences with educational computing, including the use of computer and related technology in instruction, assessment, and professional productivity. The Association for Teacher Education and the American Association of Colleges for Teacher Education have similarly commissioned task forces specifically related to the need for integrating technology into teacher preparation programs. The Office of Technological Assessment (1988, 1989) has also generated several important reports on the role that technology should have in teacher education.

There are a number of research methodologies and paradigms on technology and teacher education (Waxman & Bright, 1993), the questions pursued, however, tend to focus on (a) the implementation and evaluation of instructional computing programs for preservice teachers (Handler, 1993; Petrakis, 1993), or (b) the factors affecting preservice teachers' access and utilization of computers (Gradgenett & Harris, 1994; Roblyer & Barron, 1993). Research has found that most teachers want to use technology, but their use has been limited to fairly narrow applications. In addition, relatively few research studies have addressed teacher education students' attitudes toward technology. Prior studies on teachers' perceptions of technology have found that student teachers viewed technology as being more effective at the high school than elementary school level (Padron, 1993a), and that attitudes changed more positively with respect to using computer in instruction (Brownell, Brownell, & Zirkler, 1993). It is important to examine attitudes like comfort with technology, for example, because prior studies have found that teachers who were comfortable with technology use and were aware of ways it could help them do their jobs better (Sheingold & Hadley, 1990). Very little research, however, has examined teacher education students' attitudes toward educational technology on the dimensions of liking, comfort, value, beliefs in gender- and ability-related differences in computer use, and the background characteristics or variables that are significantly associated with their attitudes. It is important to understand teacher education students' perspectives as they grapple with the dilemma during their school experience brought on by their dual role as students and teachers (Johnston, 1994).

The present study attempts to help us understand what teacher education students feel and think about educational computing so that policies and strategies can be designed to enhance the readiness of prospective teachers in integrating computers into the teaching and learning process. More specifically, the present study addresses the following research questions: (a) What are teacher education students' general attitudes toward educational computing in terms of comfort, value, liking, gender- and ability-related differences?, (b) Are there any background characteristics or variables that affect these teacher education students' attitudes toward computers?, and (c) To what extend do these variables influence teacher education students' various attitude domains?

Methods

Subjects

The participants in the study were 215 teacher education students enrolled in an upper division university in a southern state. In this state, a computer course has been mandated as a teaching certification requirement. The university is situated near the outskirts of a large metropolitan city in the south central region of the United States. The university offers a "computer literacy" course at the undergraduate level and a "computer in the classroom" course at the graduate level. Table 1 describes these subjects' characteristics.

Table 1. Teacher Education Students' Background Characteristics

Variable	f	%
Gender		
Male	30	14
Female	185	86
Years in college		
Junior	118	54.9
Senior	26	12.1
Post BA	35	16.3
Graduate	33	15.3
Other	3	1.4
Ethnicity		
White	168	78.5
Hispanic	28	13.1
Black	13	6.1
Asian	2	0.9
Grade taught		
PreK - K	36	16.7
G1 - G2	68	31.6
G3 - G5	32	14.9
G6 - G8	64	29.8
G9 - G12	15	7.0
Other	3	1.4
Age		
18-25	98	45.6
26-35	73	34.0
36-45	36	16.7
Over 45	8	3.7
How long have used computer(s)		
Not Empl.	73	34.0
1-10 hrs/wk	17	7.9
21-30 hrs/wk	31	14.4
31-40 hrs/wk	30	14.0
40hrs+/wk	38	17.7
Employment		
Never	6	2.8
0-3 months	21	9.8
6-12 months	15	7.0
1-2 years	39	18.1
2+ years	134	62.3
Kinds of computers used		
Never Used	5	23
1 kind	37	17.2
2 kinds	58	27.0
3 kinds	57	26.5
4 kinds	32	14.9
5 kinds	19	8.8
6+ kinds	7	3.3
Previous teaching experience		
None	146	67.9
Yes	69	32.1
GPA		
3.5-4.0	80	37.2
3.0-3.4	89	41.4
2.6-2.9	38	17.7
2.5 and under	8	3.7

Among these preservice teachers, 14% were male and 86% were female. About 79% of them were white, the rest were from various ethnic minority groups. Nearly 46% of them were between the age of 18 and 25, 34% between 26 and 35 years old, and 20% 35 years old or older. A majority (68%) of them had no previous teaching experience. Nearly 3% of them had never used a computer, 17% had used it for less than one year, and over 62% had used computer(s) for more than two years. About 17% of them had used one kind of computer, and 53% had used three or more kinds of computers. Over 37% of them received a 3.5 or higher grade point average (GPA) and 41% received 3.0-3.4 GPA.

Instruments

In the present study, two surveys, The Teacher Computer Attitude Scale (Violata, Marini, & Hunter, 1989) and The Ability Differences in Computer Use (Waxman, Huang, & Padron, 1992), were integrated into one instrument that was administered to all the subjects. The Teacher Computer Attitude Scale consists of four scales: (a) Sex Differences — teachers' perception of gender-related differences in working with computers; (b) Comfort — teachers' level of comfort in using computers; (c) Value — teachers' perception of the value of computers; and (d) Liking — teachers' liking for using computers. The Ability Differences in Computer Use consists of five items on teachers' view of ability-related differences in their students' computer utilization. All the scales are on a 5-point Likert rating with 5 indicating strongly agree and 1 indicating strongly disagree. A section on these teacher education students' background characteristics was also included on the final instrument.

In order to determine the instrument's reliability and validity, each scale's internal consistency reliability (alpha coefficient) and discriminant validity (scale intercorrelation) were calculated. Table 2 displays the internal consistency reliability and discriminant validity for each scale. These scales displayed adequate reliability (with alpha coefficients ranging from .73 to .95) and discriminant validity (with mean correlations ranging from -.26 to .69).

Table 2. Internal Consistency Reliability and Discriminant Validity

Scale	No. of Alpha items	Rel.	Scale intercorrelations Cmfrt	Val	Sex-D	Abil.D
Comfort	10	.95	.41	.69	-.39	-.32
Value	7	.73	.59	-.43	-.24	
Liking	10	.88	-.34	-.30		
Sex-dif.	5	.77	.59			
Ability-dif.	5	.83				

Procedures and Analysis

The surveys were administered at the beginning of the academic year to the teacher education students by experienced researchers. The survey took approximately 30 minutes to complete. These students responded voluntarily and anonymously. Correlation coefficients were computed to identify teacher education students' background variables related to any one of their attitude scales. Multiple regression analyses were conducted to provide an estimate of the magnitude and statistical significance of the correlation between each attitude scale and a combination of students' background variables.

Results

In general, descriptive results from the present study indicate that teacher education students valued educational computing very highly (M=4.08, SD=0.49) and felt quite comfortable with computers (M=3.91, SD=0.83). Their rating of liking was also positive (M=3.67, SD=0.67). A majority of them did not perceive any difference in computer use between males and females (M=1.49, SD=0.53) nor between low- and high- achieving students (M=1.87, SD=0.70).

Table 3 reports the correlation coefficients of teacher education students' demographic and technology experience variables with their response to attitude scales. The results indicate that gender, ethnicity, years in college, college grade point average (GPA), length of computer usage, and types of computer used were significantly related to one or more of the attitude scales. On the other hand, age, teaching experience, employment, and grade level taught were not related to any attitude scale. More specifically, years in college, length of computer usage, and types of computer used had a significant positive correlation with the attitude scale of "Comfort". This indicates that teacher education students who had spent more years in college and had used a variety of computers for a long period of time felt more comfortable using computers. Similarly, ethnicity, length of computer usage, and type of computer used had a significant positive correlation with the attitude scale Value. White teacher education students who used a variety of computers and for a longer period of time found computers more valuable. Furthermore, length of computer usage and type of computer used had a significant positive correlation with Liking, indicating that the longer the length of computer usage and the more variety of computers that teacher education students used the more they liked computers.

Table 3. Correlation Coefficients of Background Variables and Attitude Scales

Variable	Comfort	Value	Liking	Sex-dif.	Abil.-dif
Gender	-.17*	-.05	-.12	-.03	.06
Ethnicity	-.04	.14*	-.10	-.10	.07
Age	.11	-.08	.12	.01	-.06
Tchng Exp.	-.05	.00	.04	-.04	-.01
Employment	.06	-.11	.00	.05	.03
GPA	.01	.12	.03	-.23***	-.15*
Yrs. in coll.	.14*	.01	.03	-.03	-.09
Grade tht.	.08	.08	.07	-.06	.04
Length of cmpter. usg.	.48***	.26***	.33***	-.13	-.08
Type of cmpter. usd.	.30***	.17*	.24***	-.10	-.05

*p < .05. **p < .01. ***p < .001.

On the other hand, there were several significantly negative correlations. For example, gender had a significant negative correction with "Comfort". Female teacher education students felt less comfortable with computers than male students. In addition, teacher education students' GPA had a significant negative correlation with the scales of Sex Differences and Ability Differences. Teacher education students with a higher GPA felt that there were fewer gender and ability differences in the use of and in the ability to use computers than students with lower GPAs.

Table 4 presents the multiple regression results in standardized beta weight. The results indicate that the combination of gender, ethnicity, year at college, GPA, years of computer usage, and types of computer used regressed significantly with all attitude scales except the Ability scale. Years in college, years of computer usage, and types of computer used had significant and positive correlation with these teacher education students' comfort in working with computers. About 30% of the variation in comfort can be explained by the six demographic and computer use variables. Years of computer usage and types of computer used had significant and positive correlation with their liking for using computers. About 16% of the variation in their liking can be explained by these variables. Ethnicity and length of computer usage had significant correlation with these students' perception of the value of educational computers. White and Asian American teacher education students tended to perceive higher value of educational computing than Hispanic and African American students. However, only 11% of the variation in value can be explained by these variables. Teacher education students' GPA had significant but negative correlation with Sex Differences scale. These students who reported higher GPA perceived fewer gender-related differences in computer use than their counterparts.

Table 4. Multiple Regression Results of Background Variables on Attitudes Scales

Variable	Comfort	Value	Liking	Sex-dif.	Abil.-dif
Gender	-.06	.00	-.10	-.12	-.01
Ethnicity	-.09	.13*	-.12	-.07	-.05
GPA	.03	.10	.07	-.22**	-.14
Yr. at coll,	.21**	.03	.08	-.08	-.10
Length of cmpter use	.42***	.23***	.27***	-.11	-.07
Types of cmpter. usd.	.19***	.08	.16*	-.06	-.09
F	15.11***	4.23***	6.48***	3.58**	1.53
R^2	.30	.11	.16	.09	.04

*p < .05. **p < .01. ***p < .001.

Discussion

The findings of the present study support previous research reports that found that the longer the exposure of computers and the more types of computers prospective teachers had experienced, the more comfort they felt in working with computers (Liao, 1993). These two variables are also closely related to these teachers' liking of computers. When teachers felt at ease with computer use, they enjoyed it more. Therefore, it is very important to provide prospective teachers the availability and training to use computers effectively.

More teacher education students from White and Asian ethnic backgrounds than from other ethnic groups rated educational computing as very valuable. Since no difference in years and types of computer used were found among these ethnic groups, the perceived difference in value may be attributed to other factors such as heritage, social economic status, and so forth. Further research needs to be conducted to identify factors that may explain this difference.

In her study on teacher education students' attitudes toward equity issues in technology, Padron (1992b) found that these teacher education students did not view gender or ability level as an issue in terms of students being able to learn and enjoy computer applications. The results of this study not only support her findings, but also reveal that prospective teachers of greater academic achievement appeared to be more confident in the equality of computer competency than their counterparts.

The findings of the present study have several educational implications. First, the findings provide insight in understanding prospective teachers' perceptions of the value of educational computing and their level of comfort while actually working with computers. Second, the study identifies some background variables of teacher education students, such as gender, GPA, and ethnicity which were significantly related to different attitude domains. Third, it provides some empirical evidence for incorporating technology in teacher education programs. Previous studies on promoting technology in teacher education have pointed out the need to: (a) provide more technology training for teacher-education faculty who are preparing tomorrow's teachers (Stephen & Ryan, 1992) and (b) restructure the introductory computer and methods courses (Handler, 1993). The findings of the present study provide some insight into the importance of attitudinal factors and are similar to other studies. Overall, the results tend to validate the hypothesis that technology experience influences prospective teachers' attitudes. In other words, this study found that previous technology use and attitudes toward technology are significantly related, although the magnitude of the relationship varies, depending upon the specific attitudinal dimension. Future studies need to explore what other variables influence teacher education students' attitudes toward technology.

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From Coursework to the Real World: First-Year Teachers and Technology

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The trials and tribulations of first year teachers have been well-documented. Prompted by mounting evidence that many novice teachers are "professionally at-risk" (Darling Hammond, 1990; Dworkin, 1980; Huling-Autsin, 1987; Lortie, 1975), colleges of education have been increasingly concerned with the professional adjustment and performance of their students following graduation. Studies that track graduates through their first years of teaching are proliferating as the National Council for the Accreditation (NCATE) emphasizes the importance of continued support for first-year teachers by the institutions that prepared them. As colleges of education consider the effectiveness of their teacher education programs, it becomes imperative that they look beyond the university classroom to the realities that their graduates face in schools where they begin their careers.

This paper will report the results of a pilot study that investigated the needs and concerns of first-year teachers in our local school district. Data were collected regarding: a) the general concerns of first-year teachers, b) the problems they encountered, c) the support they desired and received, d) and the degree to which they felt prepared to implement various teaching and management strategies (including the integration of technology). An overview of the survey's general findings will be provided as context for this paper's main focus—technology use by first-year teachers.

Background

First-year teachers face a myriad of obstacles to professional competency. Their concerns often focus on controlling the class rather than on specific tasks of teaching (Fuller, 1969) and they tend to be less aware of instructional sequences and the meaning of classroom events than their more experienced colleagues (Carter et al., 1988). First-year teachers have more difficulty applying academic theory to classroom practice (Godley, Wilson & Klug; 1985) and tend to have trouble making rapid judgments in a dynamic classroom environment. Many are overwhelmed by the mountains of paperwork related to both instruction and record keeping (Houston, Marshall, & McDavid, 1990). To make matters even more complex, they are often assigned outside of their areas of expertise or experience (Huling-Austin, 1987)

Technology Use by First-Year Teachers

In considering these demands and concerns, how can we expect first year teachers to embrace technology and effectively integrate it into their curriculum? The literature suggests that under current conditions, it may not be realistic to expect too much early on. Novak & Knowles (1991) employed a case study methodology to examine beginning elementary teachers' use of computers in classroom instruction. They found that the beginning teachers spent their early teaching experiences struggling to survive as they settled into their role as teacher. Computer usage was not emphasized because the teachers viewed computers as "extra" and "special," not as general tools to enhance the instructional process. As teachers gained confidence and experience, their use of computers expanded, though they overwhelmingly felt constrained by time—time to plan for the computer and appropriate software, and time for students to access computers during the school day.

Consistent with the findings of Novak & Knowles, Hunt (1994) reported that time was the most critical factor limiting instructional computer use by beginning elementary teachers. Hunt also found that when beginning teachers do use computers, they rarely venture beyond word processing and/or drill and practice games.

Perhaps the most widely cited use of technology by preservice and first-year teachers has been in the area of telecommunications. Merseth (1992) describes how networks can help first-year teachers obtain specialized support, encouragement, and opportunities for professional support. *The Technology and Teacher Education Annual* is one of several sources that has a wide range of articles describing the application of telecommunications for teachers.

Teacher Preparation and Technology

An early, widely disseminated study reported that only 29% of the respondents to a national survey of education majors felt prepared to teach with computers (U.S. Congress, 1988). Subsequent studies are not much more encouraging. In a survey commissioned by the Office of Technology Assessment (OTA), Willis, Austin, & Willis (1994) found that more than half of teacher education graduates who responded said they were not prepared or poorly prepared to teach with technology. Approximately 25% claimed to be minimally prepared and the remainder rated themselves as prepared to varying degrees. The authors reported that "the great majority of respondents in that study said that technology was not a factor in student teaching placements and less than one in four were required to teach even one lesson that incorporated technology" (p. 19).

Topp,Thompson and Schmidt (1994) state that recent graduates surveyed claim to be interested in using technology and believe that computer related technologies are important for K-12 education. A majority of respondents, however, rate their proficiency as low and reported that they used computers infrequently.

One study suggested factors that may contribute to improved preparation for technology use by first-year teachers. From the small group of respondents in her survey who felt prepared to teach with technology, Handler (1993) identified several contributing factors: (a) course work in educational computing and technology, (b) the degree to which computers were integrated in methods classes, and (c) the observation and use of computers during student teaching.

The purpose of the current study was to investigate the needs, concerns, problems encountered, and level of preparation of first-year teachers in our local school district. While the study sought to gather specific information pertaining to our teacher education program and our local school district, it also sought to add to the general knowledge base regarding to the experiences and preparation of first year teachers.

Method

Though technology use is a major focus of this paper, questions pertaining to technology made up a small fraction of the 98-item survey that was distributed to 211 first-year elementary teachers. Seventy three surveys were collected for a return rate of 35%. Eighty nine percent of the respondents were female; 59% recently graduated from the local state university, while 41% completed education programs at other institutions. Seventy nine percent of respondents graduated from undergraduate programs and 21% completed graduate licensure programs.

Results

Using a five point Likert scale teachers identified what they perceived as their greatest problems encountered during their first year (1 = not a problem...5 = a major problem). From the list of 23 possible items, the most significant problems (where the mean rating was greater than 2.5) were the lack of parent cooperation/involvement and grading students. Obtaining adequate access to computer resources was rated as the eighth of the list of 23 items. See Table 1 for a listing of the ten biggest problems as cited by the first-year teacher respondents.

Table 1

Top Ten Problems Reported by First Year Teachers

Problems	**Mean**
Lack of parent cooperation/ involvement	2.82
Grading students	2.58
Amount of paperwork	2.46
Sufficient opportunities to observe teaching demonstrations	2.37
Non-involved students	2.30
Lack of personal time	2.27
Access to adequate materials & equip.	2.21
Adequate access to computer resources (hardware and software)	2.15
Managing the classroom	2.07
Managing teacher time	2.07

When rating the problems encountered, respondents were also asked to select the three most serious problems for them and explain why. Ten respondents described problems regarding computer access. While one respondent stated that there were no computers available for students, most cited some, though less than optimal access to computers and appropriate software. A related issue of time was raised by some. One teacher wrote, "There are not enough computers for every room so scheduling computers for your room is almost more trouble than it's worth." Another stated, "I only had access to one computer in the classroom. I tried pairing students up to take turns at the computer, but I felt this was quite ineffective with 34 kids in the room. We have a CD-ROM available to check out, but we still have the problem with finding the time for all to benefit."

Teachers also rated the degree to which they felt prepared to perform various aspects of teaching by their coursework and their field experiences. Based on a list reported in a previous survey (American Association of Colleges for Teacher Education, 1987) respondents rated the following statements: (a) The coursework in my teacher education program effectively prepared me to (do the following); and (b) My student teaching experience prepared me (to do the following). A four point Likert scale was used (4= strongly agree, 3 = agree, 2 = disagree, and 1= strongly disagree). Results of the survey are listed in Table 2.

In considering both the coursework and student teaching, respondents rated their preparation for teaching with computers as lower than any other aspect of teaching listed. One significant finding (p< .05) regards the comparative rating given to the effectiveness of student teaching in preparing teachers to use computers. With a mean rating of 2.5, teaching with computers is the only area in which respondents rated the value of their student teaching experiences lower than that of their coursework. It should also be noted that the 2.5 rating is significantly lower(p< .05) than all other ratings for student teaching.

Table 2
Teacher Ratings of the Effectiveness of Preparation Received From Teacher Education Coursework and Student Teaching

Aspects of Teaching	Course-work	Student Tchng
Plan instruction	3.1	3.5
Work with other teachers	3.0	3.4
Use a variety of appropriate methods	3.3	3.4
Deal with misbehavior	2.4	3.2
Develop materials	3.0	3.2
Manage classrooms	2.6	3.1
Respond to student diversity	2.8	3.1
Develop curriculum	2.8	3.1
Evaluate learning	2.5	3.0
Assess learner needs	2.6	3.0
Teach with computers	2.6	2.5

Discussion

Though results of this pilot study cannot be reliably generalized, some findings are worth noting. Respondents rated adequate access to computer resources eighth on a list of 23 problems encountered by first year teachers. While at first glance this finding would not seem especially positive, it does at least suggest that those teachers value access to technology as a favorable condition to support teaching and learning.

Regarding their teacher preparation program, it appears that when compared to earlier findings (American Association of Colleges for Teacher Education,1987), teaching with technology may at least be "climbing the charts" when considered with other aspects of teaching. The AACTE study reported less than 30% of student teachers ready to teach with computers compared with nearly 70% readiness for the next closest category: developing curriculum. While the current study also shows a low level of preparation for teaching with computers, the gap between teaching with computers and other aspects of teaching appears to be decreasing.

Probably the most alarming finding of the current study involves the low rating for the value of student teaching as it pertains to working with computers. This finding seems consistent with the recent survey of Willis, Austin & Willis (1994) in which it was reported that technology was barely considered in student teaching placements and only a minority of student teachers were required to teach one lesson using technology.

Implications

Findings of the current study are consistent with the mounting evidence that preservice teacher education programs are not adequately preparing graduates to teach with computers and related technologies. In a forthcoming chapter on information technology and teacher education, Willis and Mehlinger (1994) conclude that "students are not learning to use technology in their programs and without significant changes in teacher education programs, that will continue to be the case" (p. 104). While improvement in the amount and quality of course work in educational computing provides one way of addressing these needs, authors have recognized that one required class is inadequate to prepare teachers to use technology effectively (Bitter & Yohe, 1989; Fulton, 1989; Hunt, 1994; Strudler, 1991; Wetzel, 1993). Many have argued that technology use should be modeled throughout university coursework, particularly in educational methods classes (Bitter & Yohe, 1989; Gunn, 1991; Novak & Berger, 1991; Strudler, 1991). Furthermore, it appears critical that preservice teachers observe and apply technology throughout their practicum and student teaching experiences (Bosch & Cardinale, 1993; Brown, 1992; Handler, 1993; Hunt, 1994; Topp,Thompson & Schmidt,1994). While exposure to educational computing and technology in coursework lays a much needed foundation, integration of technology into field experiences is arguably the most critical need for preparing graduates to use technology—and clearly, it is the most sorely lacking. As Willis and Mehlinger (1994) conclude, programs that are "actively exploring integrating technology into methods courses and student teaching activities...are so rare that they cannot even be called cutting edge at this point" (p. 105).

In conclusion, it seems clear that the agenda for those promoting technology in teacher education must be to progress from individual "pockets" of innovation (whether they be in isolated methods classes, K-12 classrooms, or schools) to comprehensive, systemic change. We must systematically integrate technology into all methods courses and institutionalize the application of technology in the field by making that expectation explicit when selecting cooperating school sites. While there have been many obstacles to moving forward with true integration of technology (e.g, inadequate computer resources, lack of commitment to technology integration by education faculty, K-12 teachers and administrators, and community members), current conditions appear more favorable. The time may be right to begin institutionalizing needed changes.

As we do proceed with this agenda, it becomes increasingly important that we gather data to inform our efforts. Willis and Mehlinger(1994) rightly suggest that there is a need for more research that goes beyond "threshold questions" ("Do you use technology in the course you teach?" or "Did you use a computer in your preservice program?") to get at specifics of "*what* is taught in *which* classes using *what* methods" (p. 104). We need to consider the growing body of current studies in this area and build upon that work. Clearly, we need further research to document specifics of current practices and levels of preparation, and we need to begin to identify specific approaches that are showing promising results.

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Considerations Before, During and After Using Technology in a Classroom

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In dealing with a change in education, one must ask the question "Why change?" It was in the early 1960's that critics began to look at schools. Lowered national standardized test scores were questioned. The Educational Policies Commission established the Central Purpose of American Education to plan to live in a distant future in which things will be different from the way they are now. Everywhere about us we see a bewildering pace of change - changes in economy, technology, transportation, and communication. An insight into the process of school change has educators looking deeper into the teaching process, increasing awareness of site-based problems, and pursuing strategies for solving problems.

The 1970's dealt with educational "accountability" from parents, politicians, and taxpayers. Educators became accountable for the achievement of children in their care. However, the recognition on the part of many people is that schools can be helped by improving the people who work in them. The fact that the teacher is the agent of change in education leads many hopeful people to conclude that the way to improve American education is to improve the systems by which teachers are prepared. Teachers know the system in which they work. They understand the norm. Teachers in a district can identify with the system's needs and aspirations.

John Goodlad (1990) points out that it is research and preparation of teachers and educational leaders that are the keys to the development of good schools. Action research holds potential for helping teacher leaders develop a better understanding of the problems of computer implementation and the parameters surrounding educational change (Strudler, & Powell,1993). This site-based research is geared toward finding solutions to practical problems. Teachers select a problem for study, develop an informed framework for making decisions, and develop a basis for making effective changes in practice.

Promoters of change need to be committed and skilled in the change process as well as the change itself (Fullan, 1991, p. 95). With this understanding of change, teachers develop a framework consisting of a problem framing stage, management and preparation for the change stage, recognition of impediments to the change, and enhancement of professional knowledge of effective change as well as the use of technology in the classroom.

How do teachers develop a knowledge of the use of technology in the classroom? A survey of deans, faculty, and computer coordinators at the 15 largest U.S. schools of education revealed "...technology does not permeate a student's typical preservice education experience, and that is a major impediment to technology use once they become teachers." (Schools of Education, 1991, p.21).

Neither a core course in computer technology nor an integrated model alone may provide the training that preservice teachers need. Upon exiting a core course, the student will have predictable general computational skills. In an integrated model, education faculty must use computer/technology to facilitate instruction in many curricular areas, allowing the students to observe the use of technology in particular disciplines. Also necessary are components that allow students to analyze software within disciplines and field experiences practicing the use of technology in the classroom.

Wetzel, (1993) found that technology may not be integrated in courses for education majors. Reasons given were a lack of knowledge of how to use computers in instruction, no room in the present curriculum, and a lack of software/equipment. A willingness to do so was evident through survey results.

Fewer than one third of education majors and practicing teachers perceive themselves as prepared to teach with computers (U.S. Congress, OTA, 1980). "Computers will have their ultimate impact only when faculty members are presented with vivid images of how computers will change the classroom and change what students do when they study." (Kosma, 1991, p.23). There are programs that appear effective in using technology in classroom instruction. Pioneers have advanced to that stage which Naisbitt (1982) describes as users discover new functions for the technology based on its potentials and inquiry of what can be done now that was not possible before? Increasing numbers of educators are experiencing the power of technology (Peck, & Dorricott, 1994).

Teacher's top concerns are the ease of use and how the computer fits into the existing curriculum. Computers and software are not solutions in themselves. Software allows the activities but the teacher or student must develop the activities (Kanning, 1994).

Examples of computer capabilities that are being used are communication with other classes, access to CD-ROM databases in school libraries, log on to Internet and HyperCard presentations. The approach that has shown the most success in programs is when it helps the students reach existing curriculum goals.

Urban success stories indicate that if exciting and challenging things are happening at school, students will be there for fear of missing something. Enhancing this desire for learning with an environment that uses technology can enhance every aspect of learning (Richey, 1994).

The intent is not to increase hardware in schools, but to view technology as a tool to improve the teaching and learning process.

The development of a teaching staff that not only knows how to use a computer but also understands the computer-education relationship is most valuable. Projects and models of implementation that result in educators comfortably using and experimenting with technology are rare (Schrum, 1993). There is a need to develop examples of technology rich situations in schools.

Common issues outlined by Schrum's study (1993) that should be considered prior to implementing technology include:

1). communication, both vertically and horizontally. What needs to be done and who is responsible for it?
2). time; new ways of conceptualizing the teaching process.
3). commitment; an administration committed to the changes they are talking about.
4). consultants; aid in the implementation; be a long-term part of the process; and held accountable for promises made.

Teachers and Educational Systems Analysis

The business world, along with many other large organizations like the government and the military, has been using systems analysis for a long time. Systems analysis is the study and solution of problems (Floyd, 1991). It is a methodology for studying a system in order to create a new system, change the existing system or do away with an old system. As mentioned above, it is of concern to teacher educators how we prepare teachers to deal with technology in their classrooms. Introducing teachers to educational systems analysis would give teachers a look at some time tested methods for dealing with change and how to implement it. Why should the education community not borrow methods that have been used with great success in other realms?

The set of steps followed during systems analysis is often called the systems development life cycle. The word cycle is used because in most cases the first step after the implementation of a system change is to begin to work on a new change. The following is a brief discussion of the steps of one systems development life cycle. Since a classroom or school is a system, these steps can be tailored to an educational setting.

Initial Request

There should be some formal method for a request for change to be handled within a system. There may be a form to fill out or permission may need to be sought from management. In a teacher's case the request may not need to be formalized as much as in a business setting. The change may even be mandated by management.

Feasibility Study

Once a change has been requested, a study should be done to determine if it is feasible to make the change. There should be consideration of time, resources, and technology. This is not a study to determine if the change will create some type of positive result. This is a study to see if the change can be implemented. It is assumed that whoever made the request for change did research to determine if the change could lead to a positive result.

Definition of Requirements

This a detailed report of exactly what the new system will be required to do. This cannot be a vague or general report. It must be very detailed and carefully done. Part of the reason for this is that this report will guide the developer of the system and will later be referenced to judge whether or not the systems was developed according to original expectations. In some cases it can form the foundation of a contract between developer and client.

Evaluation of Alternative Solutions

During this step various solutions are evaluated. Each alternative solution must meet the requirements from the previous step and must address all system components. System components (Kroenke, 1993) are:

1). hardware
2). software
3). data
4). procedures
5). personnel
6). networking/communications

What this means is that any solution must do what it is expected to do and must address all system components.

For example, personnel cannot be overlooked in any solution. That would prevent hardware and software from being purchased without consideration for the training of personnel. That would be very important in education today.

Creation of the New System

This is primarily a paper creation. Design and development of the selected solution is completed. At the end of this step purchases are made and any preparation of materials or construction is begun.

Installation

This is the stage where the system is unveiled and brought into operation. Too many times, in education, a lab is installed and then plans for how to use it need to be formalized.

Evaluation

The new system must now been tested to see if it does what was required of it. This can be a long process and usually means that the system must be closely monitored for a complete organizational cycle. This could be fiscal year in business. In education it would depend on how extensive the system was. The key here is that someone who knows these steps will know that evaluation is going to take place and will prepare for it. Perhaps that means pretests or an organized look at the present system in order to evaluate it against the new system.

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Effects of Technology Use on Classroom Instruction in Middle School Mathematics

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One of the current major challenges in mathematics education is anticipating how the integration of technology will change classroom instruction and student learning (Olive, 1992). Although there have been a large number of theoretical and conceptual articles that have discussed the potential of technology for changing the nature of teaching and learning in classrooms (NEA, 1991; Rockman, 1991; Sheingold, 1990; Wilburg, 1991), there have been very few empirical studies that have specifically examined how instruction actually changes in the classroom as a result of using technology. Most of the research that has examined classroom instruction has been either: (a) evaluation studies that have typically compared the effects of a specific technology program on teachers' instructional behaviors or (b) research studies that have examined instruction while students are working at a computer (see e.g., Anderson, Tolmie, McAteer, & Demissie, 1993; McLellan, 1991).

Swan and Mitrani (1993), for example, compared the classroom interactions between high school students and teachers involved in (a) computer-based instruction and (b) traditional instruction. They found that student-teacher interactions were more student-centered and individualized during computer-based teaching and learning than traditional teaching and learning. The actual purpose of their study, however, was to examine the effects of two different integrated learning systems that were used in the participating classrooms rather than investigating the more general effects of teachers who use technology versus those who do not choose to use it. In another study that examined changes in classroom instruction as a result of technology, Sandholtz, Ringstaff, and Dwyer (1992) found that high access to computers enabled teachers to individualize instruction more. In a national study, Worthen, Van Dusen, and Sailor (1994) found that students using a computerized integrated learning system (ILS) in both laboratory and classroom settings were more actively engaged on learning tasks than students in the non-ILS classrooms.

While these previous cited studies provide some important empirical support that computer-based instruction changes classroom processes and students' behavior, there are also other studies that have found that technology does not always change teachers' classroom instruction (Carey, 1991; Riel, 1989). Carey (1991), for example, observed 16 teachers in regular classroom settings and in computer-augmented classrooms and found that there were no significant differences on teachers' behaviors between these two types of settings. More large-scale, naturalistic studies are needed to investigate if classroom instruction differs when technology is used and if so, how it is different. The purpose of the present study is to examine whether the instruction of middle school mathematics teachers differs in classrooms where technology is used. More specifically, this study examines whether (a) classroom interaction, (b) selection of activities, (c) instructional activities, (d) organizational setting of the classroom, and (e) student on-task and off-task behaviors in the classroom significantly differs according to the degree of implementation of technology in mathematics classrooms.

Methods

Subjects

The subjects in the present study were 2,189 middle school students who were randomly chosen from a multiethnic school district located within a major metropolitan city in the south central region of the United States. The school district was selected to be included in the present study because it had recently been awarded a grant from the Department of Education involving the integration of calculators in mathematics instruction. All 7,000 middle school students in the school district were issued a calculator as a result of the grant, and all middle school mathematics teachers received at least 12 hours of training on how to integrate calculators in the mathematics curriculum. Computer laboratories for mathematics were also readily available in each of the five middle schools included in the study. The school district was also selected because it had a very heterogeneous school population and all the mathematics classes included students from the four predominant ethnic groups (i.e., white, African American, Hispanic, & Asian American).

The majority of the students in the present study were from lower-middle to upper-middle class families. Their overall achievement level was slightly higher than the national average. The gender distribution among these students was nearly equal: 49.4% female and 50.6% male. About 32% of the students observed were white, 26% were African American, 20% were Hispanic, and 23% were Asian. About 38% of the students were sixth graders, 32% were seventh graders, and 30% eighth graders.

Instrument

The instrument used in the present study was a modified version of the Classroom Observation Schedule (COS) (Waxman, Wang, Lindvall, & Anderson, 1983). The COS is a systematic observation schedule designed to document observed student behaviors in the context of ongoing classroom instructional-learning processes. Individual students are observed with reference to (a) Classroom Interaction—whether there is any interaction in the classroom, the purpose of such interactions, and whether it is the teacher or another pupil who is interacting with the student, (b) Selection of Activity—whether the teacher assigns the activity or student are allowed to select it, (c) Instructional Activities—the actual assignments or activities that students are observed working on, (d) Classroom Setting—the classroom organizational setting or type of instructional grouping in which observed behaviors occur, and (e) Student Behaviors—whether the student is on-task, waiting for the teacher, or off-task (e.g., distracted, disruptive, or uninvolved). For the present study, the type of technology used was added to the observation schedule. Four indicators were used to measure the percentage of time that calculators or computers were used in mathematics classrooms. The median interrater reliability (Cohen's Kappa) of this instrument was found to be .98 in the present study which indicates that the instrument was very reliable.

Procedures

The observations were conducted by trained observers in mathematics classes during the beginning, middle, and end of the school year. Neither teachers nor students were notified of the purpose of observation and arrangements were made to observe during regular classroom instruction periods. Stratified sampling techniques by students' sex and ethnicity were used so that approximately six students from each mathematics class were randomly chosen to be included in the sample. Each student was observed for 10 intervals (each interval was 30 seconds) during the approximately 50 minute data-collection period. After aggregating all of the data by class in order to determine how often students in each class were observed using technology in their classes, three levels or categories of technology use were determined: (a) Moderate Use of Technology—classes where technology was used more than 20% of the time, (b) Slight Use of Technology—classes where technology was used between 11 and 19% of the time, and (c) Infrequent Use of Technology—classes where technology was used less than 10% of the time. A multivariate analysis of variance (MANOVA) revealed that there were significant differences among the three categories or groups on technology use (*Wilks Lambda* = .882, F= 23.59, p = .0001, df = 12, 4362). Students in the Moderate Use of Technology group used technology about 28% of the time which was significantly more than students from the other two groups. Students in the Slight Use of Technology group were observed using technology about 15% of the time which was significantly more than students in the Infrequent Use of Technology group who were observed using technology only 6% of the time. In terms of type of technology used, calculators were the most prevalent type observed used, while computers were only used about 1% of the time.

MANOVA was used to determine whether there were significant differences on each of the five COS areas by the three levels or groups of technology use. Follow-up univariate analysis of variance (ANOVA) post hoc tests were used when significant multivariate differences were found. When the univariate *F-tests* were significant, *Duncan* post hoc tests were used to examine where the differences were. The level of statistical significance in the present study was set at $p < .01$ because of the large sample size.

Results

Table 1 reports the MANOVA, ANOVA, and Duncan post hoc tests for the five categories of the COS as well as the means and standard deviations by level of technology use. The MANOVA results indicated that there was an overall significant multivariate effects for the categories of (a) Classroom Interaction, (b) Instructional Activities, (c) Classroom Setting, and (d) Student Behaviors. There was no significant multivariate effect for the category of Selection of Activity. The univariate post hoc results reveal that for the category of Classroom Interaction, there were significant effects on the variables of (a) No Interaction, (b) Instructional Interactions with Teacher, and (c) Instructional

Interactions with Students. The Duncan post hoc test revealed that students in the Moderate Technology Use (MTU) group were observed working independently significantly more than students in the Slight Technology Use (STU) group and Infrequent Technology Use (ITU) group . Students in the ITU group were observed working independently significantly less often than students in the other two groups. On the other hand, student in the ITU group were observed having significantly more Instructional Interactions with their Teacher than students in the STU and MTU groups. Students in the MTU group were observed interacting with the teacher for instructional purposes significantly less than students from the other two groups. Students in the MTU and ITU groups were observed interacting with students for instructional purposes significantly more than students in the STU group.

For the category of Instructional Activities, the univariate post hoc tests revealed that there were significant differences for the variables, (a) Working on Written Assignments, (b) Taking Quizzes, and (c) Watching or Listening. Students in the MTU and STU groups were observed Working on Written Assignments significantly more than students in the ITU group. Students in the MTU group were also observed Taking Quizzes or Tests significantly more than students in the STU and ITU groups. Students in the ITU group, however, were observed Watching or Listening significantly more than students in the other two groups. Students in the MTU group were observed Watching or Listening significantly less than students in the other two groups.

For the category of Classroom Setting, the univariate post hoc tests revealed that there were significant differences for the four variables of (a) Whole Class, (b) Small Group, (c) Independent, and (d) Other Setting. Students in the ITU group were observed being in whole-class settings significantly more than students in the other two groups, while students in the MTU group were observed significantly less often than students in the other two groups. Students in the MTU and ITU groups were observed in small-group settings significantly more than students in the STU group. Students in the MTU and STU groups were observed in independent or individualized settings significantly more than students in the ITU group. Finally, students in the MTU group were observed in other settings (e.g., paired situations or medium-sized groups) significantly more than students in the other two groups.

For the category of Student Behaviors, the univariate post hoc tests revealed that there were significant differences for the three variables of (a) On Task, (b) Off task, and (c) Waiting. Students in the MTU group were observed being On Task significantly more than students in the other two groups. Students in the ITU group were observed being significantly more Off Task than students in the other two groups. Students in the STU group were observed Waiting significantly more than students in the other two groups.

Discussion

The results of the present study indicate that there are significant differences in classroom instruction by the amount of technology used. Instruction in classroom settings where technology was not often used tended to be whole-class approaches, where students generally listened or watched the teacher. Instruction in classroom settings where technology was moderately used had much less whole-class instruction and much more independent work. These findings are quite similar to previous research (Swan & Mitrani, 1993) that supports the notion that technology use may change teaching from the traditional, teacher-centered model to a more student-centered, instructional approach. Another important finding from the present study is that students in classrooms where technology was moderately used were also found to be on task significantly more than students from the other two groups. These findings are similar to prior studies that found that computer-based instruction increases students' time-on-task (Mac Arthur, Haynes, & Malouf, 1986; Schofield & Verban, 1988; Worthen, VanDusen, & Sailor, 1994).

Although the findings from the present study have some important educational implications, further descriptive, correlational, and especially experimental research is needed to verify these results. Longitudinal studies are also essential to adequately investigate how classroom instruction changes over time as a result of using technology. While the results of the present study do not suggest that technology (especially computers) has been widely implemented in these mathematics classrooms, these findings raise several questions that need to be addressed in future studies. Several of these questions center on determining: (a) the skills and abilities that teachers need to effectively implement technology, (b) the factors that constrain teachers from using technology, and (c) the types of support teachers need to implement the use of technology (Olive, 1992). Other important issues that need to be addressed in future studies include investigating *how* technology changes teachers' planning processes and instructional behaviors as well as how it affects students' time-on-task and learning in mathematics.

Preservice teacher education usually includes training on instructional strategies and classroom management techniques, but since little is known about instruction in technology-enriched classrooms, many beginning teachers are unprepared to teach in such settings (Sandholtz, Ringstaff, & Dwyer, 1992). Furthermore, when preservice teachers have field experiences in schools, they typically are sent to observe traditional classrooms rather than settings where technology is incorporated into instruction (Barron & Goldman, 1994). Consequently, we are beginning to see more Colleges of Education establish technology-enriched, professional development schools (PDS) in school districts that provide preservice teachers the opportunity to observe effective instruction with technology. These settings may help us prepare teachers who can effectively implement technology in the classroom. If technology is going to be effectively implemented in classrooms, however, we must also help veteran teachers: (a) learn how to appropriately integrate technology, and (b) change from their traditional, teacher-directed instructional approaches to more student-centered approaches that incorporate more independent student work, cooperative efforts among students, and authentic, challenging tasks (Cuban, 1993; Kozma & Croninger, 1992). Technology-enriched classrooms can help facilitate the changing of the role of teachers from a deliverer of knowledge to one of a facilitator of learning (Wiburg, 1991) and they can also change the current models of teaching and learning to one that emphasizes more active student learning (Sheingold, 1990). The results from the present study provide some support that changes in these directions may occur as a result of using technology.

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Table 1.
Classroom Observation Schedule Results by Level of Technology Use

(n =720)(n=749(n= 720)	Infrequent Use		Slight Use		Moderate Use		
	M	*SD*	*M*	*SD*	*M*	*SD*	*F*
CLASSROOM INTERACTION							
(*Wilks Lambda* = .934, *F* = 12.52, *p* = .0001, *df* = 12,4362)							
No Interaction/Independence	21.97c	27.73	33.72b	28.84	38.08a	30.89	58.84**
Instructional Interaction with Teacher	60.27a	31.57	50.79b	30.79	44.93c	30.65	44.88**
Managerial Interaction with Teacher	7.63	10.65	8.64	11.70	7.58	10.42	2.20
Instructional Interaction with Students	3.98a	13.10	2.56b	7.59	4.46a	10.32	6.47*
Managerial Interaction with Students	4.04	10.90	3.51	9.67	3.23	8.88	1.27
Other Interactions (e.g., support staff)	2.11	11.63	0.65	4.66	1.72	12.28	4.14
SELECTION OF ACTIVITY							
(Wilks Lambda = .997, *F* = 1.69, *p* = .1487, *df* = 4,4370)							
Teacher-Assigned Activity	98.53	10.71	98.80	9.29	99.56	4.57	
Student-Selected Activity	1.33	10.06	1.07	8.56	0.30	2.66	
INSTRUCTIONAL ACTIVITIES							
(*Wilks Lambda* = .940, *F* = 7.54, *p* = .0001, *df* = 18,4356)							
Working on Written Assignment	27.82b	26.95	6.01a	27.34	36.51a	28.08	22.88**
Taking Quizzes/Tests	6.26b	20.54	8.29b	21.50	11.85a	27.10	10.72**
Interacting15.35	19.43	14.00	18.08	15.91	19.20	1.99	
Watching or Listening	61.97a	32.82	53.02b	30.76	49.71c	32.37	28.41**
Getting/Returning Materials	5.54	9.80	6.14	9.52	5.21	9.53	1.77
Doing Activities/Learning Games	2.57	11.22	2.02	9.54	2.06	9.27	0.68
Working on Manipulatives	1.23	6.82	1.78	.061	.398	.410	.92
No Activity	5.10	12.54	3.53	9.17	4.45	14.17	3.13
Other (e.g., reading, drawing)	7.28	16.23	6.44	14.84	8.11	19.68	1.76
CLASSROOM SETTING							
(Wilks Lambda = .932, F = 19.42, p = .0001, *df* = 8,4366)							
Whole Class	71.96a	32.22	60.53b	32.23	52.97c	32.81	62.58**
Small Group	2.45a	13.36	0.73b	5.04	2.05a	9.79	6.04*
Independent22.98b	30.24	36.20a	31.67	39.25a	33.40	53.44**	
Other (e.g., paired or medium group)	2.19b	8.89	2.27b	10.45	4.75a	16.63	9.94**
STUDENT BEHAVIORS							
(Wilks *Lambda* = .986, *F* = 5.28, *p* = .0001, *df* = 6,4368)							
On Task	80.29b	24.51	81.60b	21.82	83.97a	20.45	5.02*
Off Task (e.g., distracted or uninvolved)	14.99a	22.39	11.80b	19.08	10.96b	18.36	8.16**
Waiting	4.30b	8.52	6.07a	10.45	4.66b	7.88	7.86**

Note: Means with the same letter are not significantly different.
*p < .01; **p < .001.

Review of Research on the Use of Interactive Videodisc for Training: Executive Summary

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Interactive videodiscs are attractive training tools because they can offer both consistent and flexible training to large numbers of individuals over an unlimited geographic range. Their use can potentially reduce costs associated with instructors and lost time due to travel to attend training and time away from the job. In addition, the visual element of interactive videodiscs enhances the instructional potential of computer-based training.

In early 1989 the Department of Defense completed a meta-analytic review of the effectiveness and cost-effectiveness of interactive videodisc applications in military training, industrial training, and higher education. Thirty-seven studies of the use of interactive videodiscs for training were reviewed, in addition to research literature in several related areas, including research on cognition, memory, pictures, color, animation, instructional design, and computer-based instruction. This is an executive summary of the longer report which follows and elaborates on the findings of that study and is a comprehensive and qualitative review of the research literature. [1]

Findings on Related Research

Visuals

Research on the use of visuals indicates that pictures facilitate learning in both adults and children and that memory for pictures endures over time. However, pictures, color, and animation not directly related to a learning task or topic may be distracting. Detailed visuals require more time and/or assistance of cues to facilitate processing than do simple visuals.

Color

The use of color can both enhance and diminish visual acuity. When used as a superfluous addition to content, color does not contribute to learning, but when used to discriminate between elements, direct attention, or express relationships, etc., color cuing has been found to facilitate the learning of concepts.

Animation

Animation has been used extensively in computer-based training and studies show that it may be effective for children but results with adults are inconclusive. Animation should be used carefully, and like still pictures, should be directly relevant to the learning task. There is some evidence that animation can inadvertently reinforce incorrect responses when used strictly to motivate or reinforce learners.

Film

Film and soundtrack viewed simultaneously are an efficient means of transmitting information. The audio and video elements do not compete for attention. Sound should not precede film or text, and limited evidence indicates that practice on procedural tasks should not occur at the same time as interaction with a computer-based videodisc lesson.

Cognition

Organization and awareness are the two factors identified as contributing most to a learner's ability to access and use knowledge in potentially relevant situations. Organization is equivalent to connectedness and refers to the interrelationships among units of knowledge. Organization is facilitated by helping learners see the coherence of knowledge through the use of central ideas, and by representations which depict the relationships among ideas. Access and use of knowledge are also fostered when learners are made more aware of what they know and don't know about a subject. Awareness is enhanced by contextualizing knowledge, and by having learners verbalize and write about content.

Findings on Interactive Videodisc

Of the 37 studies reviewed, 14 occurred in military training settings, three in industrial settings, seven in health related settings (three addressed health topics within a military setting), and 16 took place in the college setting and one in a high-school.

Achievement

Twenty-one studies compared the use of interactive videodisc (IVD) with another mode of learning, typically traditional classroom, lecture-based instruction. Several of the military training studies compared the use of interactive videodisc to the use of actual equipment for training in the operation or repair of technical equipment. Of these 21 comparisons, 10 found significantly superior performance of students who used interactive videodiscs. The remaining 11 studies found no significant difference between learners who used the interactive videodisc and those who learned in a traditional classroom setting or used actual equipment.

Learning Time

The issue of interactive videodiscs and learning time is complex. There are two time-relevant questions 1) Do students learn faster when learning on interactive videodisc? and 2) Are students more cognitively engaged when learning on interactive videodisc? Do they spend more time on task?

Students do appear to learn faster when using interactive videodiscs. Eight studies found that students who used interactive videodiscs learned in less time than did comparison students. One study found no significant difference between groups and one found that students who used actual equipment learned in less time.

However, when researchers compared students who learned by viewing a linear video with those who learned on an interactive video, the linear-video situations were typically more efficient, and more interactivity usually meant more learning time. Four studies found that students who viewed a linear video learned faster than those who viewed an interactive videodisc, but that the achievement of students in the interactive groups was better. It is likely that learners are more cognitively engaged in learning when it is interactive, suggesting that "time on task" is increased with interactivity. However, interactivity may increase the costs of training due to the increased learning time.

Attitudes

Almost all studies that assessed learners' attitudes towards interactive videodiscs for training found positive results. Nine studies found that learners favored interactive videodiscs, two found that students preferred more time on actual equipment, one found that students preferred live role plays over simulated role plays, and four found no significant difference between groups. In military equipment-training studies, students were particularly concerned with having time on the actual equipment, but both teachers and students indicated that interactive videodiscs were useful supplements for practice time on actual equipment.

Retention

Four studies assessed retention of learning material. All four studies found that students who used interactive videodiscs performed better on delayed tests than students who did not use interactive videodiscs. Delayed testing ranged from 7 to 17 days.

Individual versus Group Learning

Only three studies assessed group versus individual learning. Students who viewed the interactive videodisc individually were significantly more efficient than those who viewed it in pairs or in a whole-class setting. However, one study found no significant difference between students who worked with the videodisc in groups of five and those who viewed the videodisc in a whole class setting.

Control

Video-based material can be viewed in a linear fashion, can be controlled by the learner, the teacher, or the program (the computer). Ten studies were reviewed that assessed the value of learner, teacher, or program control over learning with interactive videodisc. All studies found that both learners and teachers prefer control and prefer more control over less control.

Three studies assessed the value of teacher control of video-based learning. When the teacher had control over the videodisc lesson, learning was more efficient but did not result in greater achievement than when the learners had control of the videodisc. When teachers were able to access the videodisc lesson, learning was faster and achievement was higher than when the videodisc was used in a linear fashion. When the teacher was able to access the videodisc material, instruction was completed in 30% to 43% less time, although there were no significant differences in completion times between teachers who had limited or full access to the interactive videodisc.

Students who had control over the interactive-videodisc lessons performed better than or as well as students in the program-control options. In two of the three student-control studies that measured time differences, students in the linear video treatments completed their lessons in less time than students who had control over the interactive-videodisc lessons. In the third study, only high aptitude students completed lessons quicker under the learner-control condition.

Limited evidence suggests that learning appears to be more efficient when the teacher has control over the interactive videodisc, although only one study compared individual learner control with teacher control over the IVD. This issue deserves more attention and study, particularly since there are obvious cost and staffing implications.

The results of learner-control studies using interactive videodisc are consistent with earlier learner-control studies using other teaching technologies. Learner control appears to be appropriate when learners are older and more mature, are more capable, when content is familiar, and when coaching is provided to assist learners in making sound learning decisions, and provision is made for switching unsuccessful learners to program control strategies.

Practice on Procedural Tasks

Three studies assessed the interaction of practicing while viewing media presentations of procedural activities (building a lift from a toy kit). Only one of the three looked at practice while viewing an interactive videodisc. The results indicate that both practice and viewing can be helpful but that practice should not occur while one is "interacting" with the videodisc. However, viewing and practicing simultaneously results in better performance when the viewing is not interactive, and is more effective than viewing first and then practicing.

Orienting Activities

Three studies assessed the value of orienting activities, practice questions, and summary reviews. Practice questions and summary reviews appear to be greater influences on student learning than are orienting activities in the form of objectives or advance organizers. Practice was found to improve the learning of facts, but did not generalize to application items.

Science Laboratories

Interactive videodiscs provide a number of advantages over traditional science laboratories, particularly when experiments or transformations occur too fast, too slow, are too dangerous, or require expensive or delicate equipment. In addition, the computer has the added advantage of instantaneously recording and graphing all measurements, thereby freeing the student to focus on the scientific concept in question.

Students using interactive videodiscs learned scientific concepts as well as or better than students who participated in traditional science laboratories. Five studies were reviewed in which students completed college-level science laboratories using interactive videodiscs. In four of six tests, students in IVD-based labs outperformed students in traditional labs. In the remaining two tests, there were no significant differences between groups. One study assessed retention after one week and found superior retention of laboratory content for students who used the interactive videodisc.

In the one study that documented completion times, students in the IVD labs were reported to have completed their labs in 65% less time than students in the traditional laboratories. The time difference was reported to result from time required to set up, wait between data collection points, clean up, and correct errors in the traditional laboratory setting.

In one report, students in the IVD laboratory were reported to exhibit more on-task behavior, confidence, and self reliance, and in another, students who took advantage of the option to view informational branches performed significantly better on items measuring the information contained in the branches.

One study, however, found that neither students in the traditional laboratory nor the IVD laboratory were accurate in selecting and controlling variables. The researcher offered guidelines for use in the design of IVD science laboratories that may encourage students' to select variables on the basis of underlying theoretically-based principles rather than on real-world characteristics, or ease of manipulation.

Military Training

Applications of interactive videodisc to military training situations were initiated primarily to reduce costs and other problems associated with training on actual equipment or simulators. Interactive videodiscs provide opportunities to practice on costly equipment that may have limited availability and also provide a safe training environment that requires little supervision.

Thirteen studies of military use of interactive videodisc were reviewed. Three assessed the relative value of teacher control of the videodisc material and are summarized in the section under learner and teacher control. Eight studies assessed the value of the interactive videodiscs as a supplement to or substitute for actual equipment, generally considered to be costly and unavailable in sufficient quantities for training. One study evaluated the use of interactive videodiscs for training in leadership skills and was used as a substitute for role playing, while another used the IVD to provide simulated military operations on urbanized terrains (MOUT).

In the latter ten studies reviewed, six found no significant differences in achievement between students who received either traditional training or hands-on practice and those who received training and/or practice on the interactive videodisc. In two studies, IVD students significantly outperformed their non-IVD counterparts, and in one study, the findings were mixed. In none of the studies did the IVD students perform significantly worse than students in the traditional training settings.

Seven of the studies provided time comparisons, and in five of the seven, the IVD students either completed their learning in less time or completed the performance tasks in less time. In one study there was no significant difference between groups and in another, students who worked on the actual equipment performed their tasks in two and six minutes less than those in the IVD group. Time differences were not recorded on comparable scales, so more specific generalizations are not possible.

While attitudes overall were positive, there were a number of situations in which the trainees were anxious about getting practice time on the actual equipment. Both students and instructors seemed to agree that IVD training should supplement, but not replace, existing training and hands-on practice.

The primary benefit of using interactive videodisc in the types of military training reviewed is that it allows students more opportunities for practice and to receive individualized feedback in situations where costs of real equipment and/or training settings preclude sufficient practice. Interactive videodiscs were effective in three distinct types of training settings 1) operations and repair of equipment; 2) leadership training; and 3) tactical operations.

Industry and Health-related Training

Three studies of interactive-videodisc use in industrial settings were reviewed. The topics of instruction were diverse management training, sales training, and training in the proper use of hazardous materials. Two of these training units provided simulated role playing on the interactive videodisc. Four reports of the use of interactive videodisc in health-related training situations were reviewed, three of which offered training in CPR — some included practice in administering CPR to a mannequin attached to the computer which registered the treatment and provided feedback to the learner.

Of the six studies that reported achievement results, three showed statistically significant superior performance for subjects using interactive videodiscs for training. In two of the remaining three studies, there was no significant difference between the IVD groups and traditional-instruction groups, and in the third, there was no reported difference, although a statistical test was not performed. In the one study that conducted delayed testing at two weeks, the IVD group performed significantly better.

With regard to attitudes toward interactive video instruction, only four of these studies reported data and in three of these studies, results favored students who used the interactive videodiscs. In the fourth study, there was no significant difference.

In the three studies that documented instructional time, one found that learning on the interactive videodisc took twice as long to complete than linear-video learning and was equal in time to the lecture format. In another study, participant training time was reduced by 11% and instructor time by 87% using the interactive videodisc. In the last study, students completed a CPR course presented on IVD in 5 to 8 hours less than those who participated in regular classroom instruction.

Summary

Overall these results support the use of interactive videodisc for training. Achievement was always equal or superior to alternative formats, typically traditional lecture, and generally was well received by both students and teachers. In some cases, time savings appeared to be dependent on the amount of interactivity built into the IVD lesson, but savings were substantial in some cases, particularly when the traditional training situation was particularly instructor-intensive, such as in management or sales training.

Costs

Limited cost data was available to assess the cost effectiveness of interactive videodiscs for training. Of the four military studies that did include cost data, only two provided information regarding costs of the equipment the interactive video materials were intended to replace or supplement. One health-related study provided detailed cost comparisons based primarily on the time savings of learners (nurses) and instructors. In this study, cost savings that derived from reduced training and instructor time when using interactive videodiscs were substantial $28.61 per student versus $46.49 per student in the traditional classroom.

In the four military studies that provided data, hardware costs per IVD learning station ranged from $6,000 to $7,100. Software program development costs were greater and more varied $18,700 to $67,000. These costs are insignificant, however, when compared with the high price of selected pieces of military equipment — for example, $300,000 for one DCT-9000 console. One study showed substantial cost savings by amortizing the costs of the real equipment and the interactive videodisc training over time (10 years for the real equipment and 8 years for the IVD). The total cost per year was $44,988 for the real equipment and $6,067 for the complete interactive videodisc training package, including projected annual maintenance costs. In another study, the cost of the real equipment was $51,000, compared with IVD hardware costs per station of $7,180 and software development costs of $18,700; a savings of $25,120 per station — less if you consider that the software can be reproduced cheaply and be used by multiple students at the same time. An added savings accrues to the IVD-based training since the hardware can accommodate multiple software training programs.

Initial development costs of training offered through interactive videodisc can be mitigated when used in the following situations

- when there are many users,
- when it is difficult to bring users together or to reach all of them at the same time,
- when training requires the use of costly or dangerous equipment, or
- when a high degree of interactivity or individualized feedback is required.

Despite the lack of data, several conclusions can be drawn about the costs of interactive videodiscs for training. In general, they are more time efficient. Of the eleven studies that documented time comparisons, eight favored interactive videodiscs, one favored the use of real equipment, one showed no significant difference, and one favored the use of linear video over interactive videodisc. Data regarding time savings was not provided in a way that permits comparisons across studies but savings ranged from 10% to 60% and from 4.7 hours to 8 hours. These time savings can result in substantial cost savings when accumulated across large numbers of trainees. For example, if the approximately 2,500 military trainees that had participated in the studies reviewed for this report each saved four hours in training (the lower end of savings estimates), this would result in a total savings of 10,000 personnel hours. Additional cost savings can be derived from reduced instructor time (87% savings in one study) and lower equipment-maintenance costs.

Conclusion

In virtually all of the studies reviewed, students taught on an interactive videodisc performed as well as or better than students who learned in other modes, typically a traditional classroom-lecture situation. In addition, students who practiced either procedural skills, such as CPR or repair of military equipment, or role played by interacting with a simulation on the interactive videodisc, also learned as well as or better than groups who performed on actual equipment or interacted with humans. Particularly given the broad range of training topics described in these studies (e.g., 35 mm photography, intramuscular injection, first-year French, science laboratories, leadership and management training, CPR, smokeless tobacco risks, cancer chemotherapy, etc.), interactive videodisc appears to be a strong competitor-with other training options.

Attitudes towards training provided on interactive videodiscs were generally high, and often significantly higher than the attitudes of control students. Estimates of time savings with interactive videodiscs are quite mixed and one of the key variables appears to be the degree of interactivity and control available to the learner. In a number of studies, increased interactivity also increased the amount of time required to complete the training. Interactivity generally means that students can review segments, pause, and spend more or less time on sections. While such options are likely to increase learning if used appropriately, they are also likely to increase the amount of time required. Decisions regarding the degree of interactivity will need to be based, in part, on the trade-offs between time and mastery.

The issue of who controls learning on the interactive videodisc is confounded by one study that showed superior performance when the teacher controlled the IVD as compared with student control, and another study that indicated no significant difference between fully-and partially-interactivated material when used by the teacher. These subtleties will make it difficult to discern what amount of interactivity is most cost effective in which situations.

Future studies should consider the impact of interactive videodisc training or practice on long-term job performance. In the studies reviewed for this report, the longest time that had elapsed between training and testing was two weeks.

It is also important to sort out the unique characteristics of interactive videodiscs that contribute to learning. There is some evidence that much of the contribution derives from the individualized interactivity provided by the computer, and in one study, the addition of the video element did not enhance learning. It is really quite amazing that only one study was identified that compared learning on computer versus learning on interactive videodisc and this study was quite flawed. Most comparisons were between interactive videodiscs and traditional lecture-based classrooms, or interactive videodiscs and actual equipment use. Computers have been shown repeatedly to be quite efficient and effective instructors and a critical question centers on the relative contribution of visual elements to learning — particularly since the production of video material can increase costs substantially.

In addition, it was not evident that the studies reviewed considered the extensive body of research on learning and memory, particularly the more recent cognitive research base. The most frequently studied variables were learner control and practice. Computers can easily provide learners with opportunities to interact with the learning material in ways that enhance depth of processing. Research has shown that comprehension and retention is enhanced when learners can engage in activities that promote elaboration, organization, and integration of new information with existing schema. Computerized learning situations can be designed to allow the learner to interact in these ways, and yet none of the studies reviewed attempted to address these issues.

In conclusion, the initial training efforts using interactive videodiscs have been quite successful and appear to be well received. New technologies recently available or on the horizon will only enhance the power and complexity of media-based training. Research should continue, but be designed to account for the broad base of relevant research findings from other disciplines, such as psychology, linguistics, sociology, instructional design, etc., and future studies should provide data that allow meaningful cost comparisons.

Acknowledgments

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[1] *Copies of the complete report, including an extensive bibliography, can be ordered from the author.*

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Recent Graduate Perspectives on Instructional Technology: A National Survey

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MORE INFO
ON CD-ROM

The *Power On!* report (OTA, 1988) prepared for Congress by the Office of Technology Assessment remains one of the most frequently quoted documents on the use of technology in American schools. One segment of that report described the relatively poor record of teacher education programs in the country when it comes to preparing teachers to work in technology-enriched classrooms. In 1993 the Office of Technology Assessment was asked by several congressional committees to prepare another report in the Power On! tradition that would focus specifically on teacher education. In preparing the report OTA commissioned several new studies on various aspects of technology and teacher education. One study was organized by the Center for Information Technology in Education at the University of Houston. This paper summarizes the results of a survey sent to a random sample of recent graduates of teacher education programs in the United States. Other papers in this Annual summarize results of a teacher education faculty survey (Willis, Austin, Willis, and Colon) and a comparison of US and United Kingdom surveys (Davis and Wilis). A comprehensive report of the study, including raw data tables, is on the CD-ROM version of the 1995 Annual.

Methodology

Survey Instrument

The survey used in this study was a modification of the survey used in a companion survey of teacher education faculty. The questions were rephrased to indicate the respondents were recent graduates - that is, had completed their program within the last two years.

Sample

A random sample of 500 elementary and secondary schools in the United States was selected from a mailing list purchased from a commercial list provider. Both public and private institutions were included. A total of 100 surveys were returned which produces a return rate of 20%. However, a total of 70 surveys were usable and all the data in this section was based on the analysis of 70 surveys. The 30 unusable surveys were returned because the school had closed or no teacher met the criteria of having competed a teacher education program within the last two years.

Data Analysis

The survey data was coded and analyzed using RaoSoft Survey, a DOS-based commercial program designed specifically for analyzing survey data.

Results

Only a small sample of the data is presented in this paper. A more complete analysis is available on the CD-ROM version of the Annual. Table 1 summarizes the background data on the teachers who responded to the survey. A typical "recent graduate" teacher was a 26 year old female who had 2.8 years of experience and had been using a computer for over 4 years and reported beginning to use acomputer for instructional use just over one year ago.

Table 1
Recent Graduate Background Data

Mean Years K-12 Teaching	2.8
Percentage Male	13.0
Percentage Female	87.0
Mean Age	26.0
Mean Years Using a PC	
for personal use	4.2
in courses	1.4
Mean Hours Per Week Using a PC	
at home	6.4
at school	4.7

Attitudes of Recent Graduates

Three questions assessed teacher attitudes toward information technology in education. They were asked to rate the importance of information technology on a scale from 1 to 5:

1 Not Important
2 Somewhat Important
3 Important
4 Very Important
5 Extremely Important

The results are summarized below:

Question	Mean
Importance of IT in education today (65)	4.17
Importance of IT in education in ten years (65)	4.66
Importance of IT in teacher education (65)	4.49

Note: (The numbers in parenthesis indicate the number of respondents for this question.)

The means clearly indicate recent graduates believe information technology is an important aspect of education. The importance recent graduates place on information technology is indicated by the percentages for the two highest ratings: Very Important and Extremely Important. At least 74% of the respondents selected those options for all three questions.

Another common explanation of reluctance to work with information technology is anxiety. When asked, "Do you have some anxiety about using computers (or other information technologies) yourself or in the courses you teach?" only 11% reported Moderate anxiety while 44% said they had Some anxiety. Many recent graduates (44%) said they had None. Thus, while computer anxiety is not a problem for many recent graduates, a sizable number, 55%, do have at least some anxiety.

Overall Assessment of Preservice Preparation

One question asked, "Overall, how well did your teacher education program prepare you to use information technology in your teaching?" Table 2 indicates the percentage selecting each response.

Table 2
Overall Assessment of Preparation

Option	Percentage
Not Prepared at All(68)	33%
Poorly Prepared (68)	19%
Minimally Prepared (68)	33%
Adequately Prepared (68)	06%
Well Prepared (68)	04%
Very Well Prepared (68)	03%

Over 50% of the recent graduates said they were not prepared at all or poorly prepared to use information technology in their teaching. When the "minimally prepared" category is included as unacceptable, 85% give a failing grade to their preparation program. Only 13% said their preparation was "adequate" or better.

Information Technology Skills

Recent graduates were also asked to rate their level of general and education-specific information technology skills (see Table 3, N=70 indicates the number of respondents who answered this question). In general they rated their information technology skills at the Intermediate or Advanced level while education-specific information technology skills were rated somewhat lower.

Table 3
Recent Graduates' best descriptor of current level of general technology literacy

Not Literate	Novice	Intermediate	Advanced
10%	36%	47%	7%
N=70			

Best descriptor of current level of expertise about the use of information technology in education

Not Literate	Novice	Intermediate	Advanced
14%	46%	39%	1%
N=70			

Content of Technology Training

When recent graduates were asked to estimate the percentage of education faculty who used information technology in the courses they completed, the mean percentage was 40%. Approximately 64% of the recent graduates said they had been taught with or taught how to use some form of information technology. This question was essentially a measure of threshold coverage — enough for the graduate to remember that it was covered. Recent graduates also answered a series of questions about five ways they might have learned about information technology in the teacher education program they completed:

1. Faculty taught with the help of information technology.
2. Students were taught about information technology.
3. Students were required to use the technology.

4. Students were required to develop materials with the technology.
5. Students were required to create lessons incorporating IT.

They indicated which of over 50 types of technology, from simulation software to LCD panels, were used in their teacher education program. Keep in mind that recent graduates reported use over their entire program rather than use in a single course. Table 4 summarizes the type of information technology coverage recent graduates reported in their programs. An item is listed as "typical" if 51% or more of the students selected it from the list supplied.

Table 4
Typical Coverage of Information Technology (IT) in a Teacher Education Program

Type of Use	IT Items
Faculty Taught With IT	None
Students Taught About	None
Students Required to Use	None
Students Required to Develop Materials With	None
Students Required to Develop Lessons Incorporating	None

As Table 4 indicates the *typical* teacher education student does not see faculty teach with any of the more than 50 information technology items that were listed in the survey. "High percentage" items were those in the high teens and low twenties such as VCRs, word processing, drill and practice software, and tutorial programs. The taught about data is similar. Using data from recent graduates, not a single information technology item would be taught about in the "typical" program (e.g., reported by 51% of the recent graduates). Only two items would be taught about in the programs a third of the recent graduates completed: Drill and Practice and Word Processing.

Students in were required to use only one item; word processing, in a third of the programs. No IT items were "typical.." The development of materials/lessons data also yielded very low rates. Only a few items were in the teens, including word processing. None even approached the percentages needed for introductory coverage in a third of the teacher education programs.

Recent graduates were also asked to indicate which of the information technology items were covered in more than one course. Only two items were reported "covered in any way in more than one course" by 10% or more of the respondents: word processing (10%) and educational games (11%). The mean number of IT items respondents said were "covered in more than one course" was 1.3.

Educational Computing Courses

Recent graduates were asked if their program offered a "specific information technology course (educational computing, educational media, or instructional technology)." The percentage responding Yes was 74%. Only 54% said such a course was required, however. Responses by teacher education faculty on a similar survey were 84% (offer course) and 58% (require course).

Student Teaching

Two questions were asked about the role of information technology in student teaching. Of those who said they had participated in student teaching or a similar activity (64%, N=45), only 4% said technology played any role in the selection of placements. About 24% said they did not know if technology played a role and 44% said it did not. About a third (24) of the recent graduates answered a question about the role technology played in their student teaching work. The responses indicated very little use of technology was required on most placements:

Table 5
IT Requirements in Student Teaching

57%	None required
26%	Observe teachers using technology
17%	Support a teacher using technology
26%	Develop a lesson plan that incorporates technology
17%	Teach a lesson using technology
00%	Teach more than 3 lessons using technology

The figures above, while low, are probably overestimates because students who said no technology was involved anywhere in their teacher education program (34%) were instructed to skip a series of questions about technology use, including those about student teaching.

Preparedness and Current Use

Recent graduates were presented with a list of ways technology could be used in the classroom and asked to check those they were prepared to teach with. Formats are organized into three categories: established formats, recent innovations, and specialized uses. The results are summarized in Table 6.

Table 6
Percentage of Recent Graduates Who Said They Were Prepared to Teach Using a Specific Format

Established Formats	Percentage
Drill and Practice	61%
Integrated Learning Systems	21%
Tutorial Software	50%
Simulations 26%	
Games	73%
Computer-Based Assessment	14%
Computer-Managed Instruction	09%
Productivity Software	03%

Programming	10%
Recent Innovations	
Electronic Presentations	04%
Multimedia Packages	04%
Problem Solving Software	31%
Hypermedia	01%
Constructivist Software	01%
Electronic Encyclopedia	20%
Accessing databases via modem/nets	06%
Students using e-mail/ teleconferences	09%
Distance education services	04%
Collaboration over computer networks	03%
Specialized Uses	
Computer-based Labs/Probes	10%
IEP Generators	01%
Science-Math Labs	26%
Writing & Publishing Centers	50%

N=61

Fifty percent or more of recent graduates said they were prepared to teach with four different formats. One relatively new format, writing and publishing centers, was in the list along with three traditional formats: drill and practice, tutorial, and games. None of the "recent innovations" even approached the 50% level and less than one in ten recent graduates said they could use formats such as multimedia packages and electronic presentations. Considering the percentages who said they were prepared to teach with each format it is not surprising that when they were asked to indicate which forms they had actually used, the rates for most were quite low (See Table 7).

Table 7
Percentage of Recent Graduates Who Said They Had Used a Format in their Teaching This Academic Year

Established Formats	**Percentage**
Drill and Practice	41%
Integrated Learning Systems	07%
Tutorial Software	24%
Simulations	07%
Games	45%
Computer-Based Assessment	06%
Computer-Managed Instruction	03%
Productivity Software	01%
Programming	09%
Recent Innovations	
Electronic Presentations	00%
Multimedia Packages	01%
Problem Solving Software	13%
Hypermedia	01%
Constructivist Software	00%
Electronic Encyclopedia	04%
Accessing databases via modem/nets	01%
Students using e-mail/ teleconferences	03%
Distance education services	03%
Collaboration over computer networks	00%
Specialized Uses	
Computer-based Labs/Probes	04%
IEP Generators	00%
Science-Math Labs	11%
Writing & Publishing Centers	36%

N=51

Summary and Conclusion

There is very little that needs to be said about the preparation of preservice teachers to use information technology in their classroom. The data speaks loudly. On average, they are not prepared. This is in spite of the fact recent graduates have very positive attitudes toward the use of information technology in education. However, they are very dissatisfied with the preparation they received in their teacher education programs; they report very little use of information technology resources by teacher education faculty, and the information they supplied indicates they had very little contact with information technologies in their preservice programs. Perhaps most striking is the data on inclusion of specific technologies in their programs. Today, more than 20 years after the personal computer revolution became a cultural event, teacher education programs are simply not preparing technologically-aware teachers. The rates of faculty modeling, student instruction on use, student use to create materials, student inclusion in lessons, and student involvement during student teaching are so low that the inclusion of IT in teacher education must be considered an isolated and unusual event today. Progress toward effective integration across the teacher education curriculum is painfully slow.

Perhaps the results of this survey underestimate the level of activity in teacher education programs. That seems unlikely, however. Although the rate of response was relatively low, the results of this national, random survey support the impressions of many professionals in the field and are not extreme compared to other surveys.

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Faculty Perspectives on Instructional Technology: A National Survey

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In 1993 the Office of Technology Assessment was asked by several congressional committees to prepare another report in the *Power On!* tradition that would focus specifically on teacher education. In preparing the report OTA commissioned several new studies on various aspects of technology and teacher education. One study was organized by the Center for Information Technology in Education at the University of Houston. This paper summarizes the results of a survey sent to a random sample of teacher education faculty in the United States. Other papers in this Annual summarize results of a recent graduate survey (Colon, Willis, Willis, and Austin) and a comparison of US and United Kingdom surveys (Davis and Willis). A comprehensive report of the study, including raw data tables, is on the CD-ROM version of the 1995 Annual.

Methodology

Sample

Sampling presented a problem because the intent was to survey a typical range of teacher educators rather than only those designated the "computer person" for a teacher education program. To assure a representative sample 65 teacher education programs was selected from *Peterson's Guide to Colleges and Universities*. The selection process included public and private institutions, small and large, urban and rural. A list of typical courses taught in a teacher education program was also developed and packets of surveys were sent to the deans or directors of all 65 programs. Each survey had a label with the name of a particular course such as Educational Psychology, Foundations of Education, or Reading/Language Arts Methods. Deans were asked to forward the survey to the faculty member who taught the course listed on the survey lable. Postage paid envelopes and a cover letter describing the purpose of the survey were also provided.

The Survey

A comprehensive survey was developed in collaboration with OTA staff and a collaborative group of teacher educators (see the extended report on the CD-ROM for a list of scholars involved in the study and a copy of the survey). The survey included questions about the institution and teacher education program, the faculty member's history of general and instructional use of information technology, attitudes toward technology, and ratings of barriers to wider use of information technology. The survey was developed after a thorough review of existing surveys on both K-12 use of technology and technology use in teacher education. Many of the items in the survey used were based on items in previously published surveys.

Data Analysis

The survey data was coded and analyzed using RaoSoft Survey, a DOS-based commercial program designed specifically for analyzing survey data.

Results

Return Rate

The return rate was relatively low. Of the 1223 faculty

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surveys mailed to teacher education institutions, a total of 250 were usable, which is 20% of the surveys mailed. There are several possible explanations for the low rate of return. The survey was very long and the time required to complete the it may have been one factor. Another factor possibly contributing to a low rate of return was the distribution method which involved sending surveys to administrators who were then asked to distribute them to the appropriate instructors. Some administrators may not have distributed any of the surveys in the packet sent to them. Others distributed only a few of the surveys because the courses listed on many did not correspond to courses taught at the institution.

As the percentage of usable surveys was relatively low, readers should be cautioned about over-interpreting the survey data. Several surveys of technology in education have reported much higher return rates. For example, a study of central Ohio vocational teacher's attitudes toward using computers in inservice training (McCaslin and Torres, 1992), had a return rate of 72 percent, and a survey of science teacher's perceived needs relative to computing technologies (McGinnis (1991) reported a 70% return rate. Both studies mailed material directly to teachers. Even that, however, does not guarantee high rates of return. In her survey of media specialist's beliefs about a book award program Storey (1992) had a return rate of 20%, and Seels and Glasgow's (1991) survey of jobs and tasks performed by instructional designers reported 25%. When the method of distributing surveys is indirect the rates tend to be low. For example, a National School Boards Association survey of home and computer use that was mailed to 1,000 school districts had a 27% return rate (NSBA, 1984), and a survey distributed with *Parents' Magazine* (Knoll and Bedford, 1989) had a return rate of 12 percent. However, although return rates in the 20 to 30 percent range are common, the data obtained must be interpreted cautiously.

Faculty Characteristics

Table 1 summarizes data on the faculty who responded to the survey. In this table, and in other tables throughout this paper, the numbers in parentheses indicate the number of respondents who answered the survey item.

Table 1
Faculty Characteristics

Mean Years K-12 Teaching (231)	08
Mean Years Teaching in Higher Education (242)	15
Percentage Male (110)	45
Percentage Female (132)	55
Mean Age (242)	49
Mean Years Using a Personal Computer	
for personal use (242)	8
in courses (232)	5

Attitudes

Three questions assessed faculty attitudes toward information technology in education. They were asked to rate the importance of information technology on a scale from 1 to 5 with 1 being "Not Important" and 5 being "Extremely Important." The results are summarized in Table 2.

Table 2
Faculty Attitudes Toward Information Technology

	Mean
Importance of IT in education today	3.93
Importance of IT in education in ten years	4.41
Importance of IT in teacher education	4.14

(N=241)

Clearly teacher education faculty consider information technology an important aspect of education; 82% of the respondents said in ten years information technology would be "Very Important" or "Extremely Important." When asked about information technology in teacher education 76% said it was now "Very Important" or "Extremely Important." Faculty attitudes do not appear to be a barrier to information technology in teacher education. The average faculty member believes information technology is very important.

A common explanation of faculty reluctance to work with information technology is anxiety. That explanation received some support in this survey. When asked, "Do you have some anxiety about using computers (or other information technologies) yourself or in the courses you teach?" only 3% reported Severe anxiety. However, slightly less than 13% reported Moderate anxiety while 34% said they had Some anxiety. Many, 44%, said they had None. Thus, while computer anxiety is not a problem for the majority of teacher educators, a sizable number, 66%, do have at least some anxiety.

Perceived Barriers

The survey also asked about the barriers to using instructional technology. Barriers such as limited resources, background, and support were addressed. Survey questions which received the highest ratings are reported in this section.

Limited Resources. Many types of resources are necessary to support the use of information technology in teacher education. Hardware and software are, of course, obvious needs, but other types of resources such as time, support and training, and rewards are also important. Several questions about possible "barriers" to wider incorporation of information technology were related to hardware and software resources. Respondents used the scale below to rate the importance of potential barriers: from 1 - Not a Barrier to 5 - Extremely Serious Barrier

The mean response to five hardware and software barrier questions are listed in Table 3.

Table 3
Perceived Barriers to Greater Use of Instructional Technologies

	Mean
Lack of equipment (226)	3.1
Instructor/student access to equipment (223)	2.6
Little or no tool software (223)	2.6
Little or no educational software or poor quality educational software (220)	2.9
No software in my content area or poor quality software in my content area (223)	3.0

Only one item, *Lack of Equipment*, was, on average, rated above (3) Important but the remaining resource questions were at or just below that level. Responses to these five questions suggest lack of material resources, including hardware and appropriate software, is one contributing factor to low levels of information technology integration in teacher education. However, the conclusion is tentative because many of the faculty who completed the survey also said they did not currently use information technology in their courses. Many may not understand or be aware of the hardware and software resources needed to integrate information technology. Responses to other questions, however, also indicate the need for more hardware and software resources. For example, only 40% of the faculty said funds for instructional information technology were available at the department level and only 32% said funds were available from the college or school of education. However, 24% of the faculty said they had purchased hardware or software for instruction from departmental budgets and 20% said they had from college or school of education budgets. On the other hand, over a third of the faculty could not identify a single source of funds (17% Don't Know and 20% No funding available). The survey also included questions about the availability of specific hardware and software items. About 81% of the faculty had access to a VCR, 63% had a collection of six or more videotapes, and 66% could use a lab of computers. On the other hand, only 28% had access to a collection of more than 70 pieces of educational software, which is quite small considering the number of good packages available today. Even lower percentages reported access to collections of six or more educational laser discs (17%), CD-ROMs (17%), and computer controlled laser disc players (22%). (The videotapes, laser discs, and CD-ROMs could be on any topic.)

Hardware and software resources are, of course, critical components of any effort to integrate information technology into teacher education. Another resource, faculty time, is also critical. One of two questions on time resources asked if "limited time to develop instructional materials using IT" were a barrier. Fifty percent said this was a "major" or extremely serious barrier while only 7% said it was "not a barrier." The two "time" questions , which were part of a list of 19 potential barriers to wider use of information technology in teacher education, were the highest rated of all the barriers.

Support and Staff Development. The survey also addressed the question of staff development. About 2 in 5 faculty said poor quality faculty development was an Important to Extremely Serious barrier and half said more training was needed on equipment. However, of the three "barrier" questions related to staff development, the one with the highest rating was "limited in-service opportunities on integration of technology into teacher education."

Leadership. Two questions asked leadership interest. One asked if a "low level of interest on the part of school/ college of education leadership" was a barrier. Another asked about "low institutional leadership interest." Table 4 reports the data on these two questions.

Table 4
Percentage Responses to Questions About Leadership Barriers.

	In Educ.	In Institution
Not A Barrier	29%	25%
Somewhat a Barrier	26%	22%
Important Barrier	14%	18%
Major Barrier	11%	14%
Extremely Serious Barrier	06%	08%
N=216		

Leadership interest was viewed as at least an important problem by about 40% of the faculty while only one in four did not see it as a barrier.

Patterns of Use

Most faculty surveyed were, in fact, regular computer users; 86% said they owned a computer at home and reported they used it for an average (mean) of 9.6 hours a week. At the office, 82% said they used their computer for an average of 12 hours a week. Faculty were also asked to rate their level of general and education-specific information technology skills. On average they rated their general information technology skills at the Intermediate or Advanced level while education-specific information technology skills were rated somewhat lower. In general faculty see themselves as competent to use information technology.

Detailed descriptions of usage patterns indicated the great majority of teacher education faculty have access to basic personal computing resources at home and at the office, and that they have mastered the basic technology well enough to make it a productive and regular part of their academic life. Mastery, however, is generally limited to word processing and perhaps one or two other applications. There are few "power users" among the teacher education

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professoriate who use the computer technology available to them in many different ways

Other data from the survey indicate teacher education faculty have a moderate level of general computer skills. On the question of profession-specific skills the data are quite clear. While teacher educators have taken up the routine computer application of word processing, that skill has not generally been a launching pad for integration of information technology into the teacher education curriculum. To a question that asked what instructional uses of technology they felt prepared to teach with, teacher educators said they did not feel prepared to teach with any (see Table 5).

Table 5
Percentage of Faculty Who Said They Were Prepared to Teach Using Specific Resources

Established Formats	Percentage
Drill and Practice	42%
Integrated Learning Systems	10%
Tutorial Software	32%
Simulations	35%
Games	30%
Computer-Based Assessment	19%
Computer-Managed Instruction	15%
Productivity Software	08%
Programming	12%
Recent Innovations	
Electronic Presentations	15%
Multimedia Packages	15%
Problem Solving Software	13%
Hypermedia	14%
Constructivist Software	09%
Specialized Uses	
Computer-based Labs/Probes	09%
IEP Generators	07%
Science-Math Labs	13%
Writing & Publishing Centers	29%

N=165

Classroom Uses of Technology

Many of the survey items asked about use of technology in teacher education courses. That data was used to construct a list of "typical experiences" in a program.

In a typical teacher education program of 30 semester hours (exclusive of student teaching), one 3-semester hour course accounts for 10% of the program. If the faculty data on how they employ information technology in one, specific course represents the typical pattern, then any item reported by 10% or more of the responding faculty would be encountered once in a typical student's program. A reporting rate of 20% would be needed for students to, on average, see it in two courses. Using those criteria, 22 of the 56 information technology items listed in the survey would be *taught about* in at least one teacher education course. *Taught About* was defined as students reading about, discussing, watching demonstrations or videos, observing, or hearing about the item. It represents the lowest level of commitment to a topic.

Table 6
IT Resources Taught About in At Least One Course in a *Typical* Program

Taught About in One Course

- Computer-Based Assessment
- Electronic Presentation Tools
- Hypermedia
- Multimedia Packages
- Problem Solving Software
- Simulations
- Tutorial
- Writing and Publishing Centers
- Authoring Programs
- Databases
- Desktop Publishing
- Graphics Software
- Spreadsheet
- Word Processing
- CD-ROM Drive
- LCD Projection Panels/devices
- Laser disc players
- Video camera
- VCR

Taught About in Two Courses

- Computer Managed Instruction
- Drill & Practice
- Educational Games

At the lowest level of commitment, just under 50% of the information technology topics covered in the survey are dealt with in at least one course. Somewhat discouraging is the fact that only three items (computer managed instruction, drill and practice software, and educational games) would be covered in at least two courses in a typical program. Teaching about something can represent as small a commitment as mentioning it in a lecture or assigning a chapter from a textbook that has a few paragraphs about the topic. A more significant commitment, especially in professional preparation programs, is to use something yourself.

Using the criteria described above only 17 of the 56 items would be used by a faculty member in at least one teacher education course (see Table 7).

Table 7
IT Resources Used By Faculty in One or Two Courses in a *Typical* Program

Used in One Course	Used in Two Courses
Cmptr. Managed Instruction	VCR
Drill & Practice	Word Processing
Educational Games	
Electronic Presentation Tools	
Multimedia Packages	
Problem Solving Software	
Simulations	
Desktop Publishing	
Graphics Software	
Presentation Software	
Spreadsheet	
CD-ROM drive	
Large screen monitor	
LCD projection panels/devices	
Video camera	

Tool applications and traditional educational uses of computers such as drill and practice and games are represented on the list as well as resources that support traditional lecture/discussion instruction. Multimedia, the current "hot" topic in education, is also represented. Perhaps the most surprising thing about this data, however, is that 15 of the items would be involved in only one course in a typical program. Only two things, a VCR and word processing, would be used in more than one course.

The other three types of use covered in the survey reflect progressively more professional levels of student involvement in the use of the items for educational applications: *required to use information technology*, *required to develop materials with information technology*, and *required to create lessons that include information technology*. There is, unfortunately, little encouraging in the data summarized in Table 8. Students would *use* only nine items in a typical program and eight of them would be used in only one class. No items would be used to *create materials* in even one course, and word processing would be the only information technology item *included in a lesson plan* developed by the student.

Table 8
Uses by Students in a *Typical* Program

Students Required to Use In		
	One Course	**Two Courses**
	Drill and Practice	Word Processing
	Educational Games	
	Electronic Presentation Tools	
	Problem Solving Software	
	Simulations	
	Graphics Software	
	Video camera	
	Video player	
Students Required to Develop Materials With		
	In One Course	In Two Courses
	—	—
Students Required to Create Lessons Including		
	In One Course	In Two Courses
	Word Processing	—

Assistance to Student Teachers

Three questions asked about the role of information technology in student teaching. Of those who said they were involved (40%, N=100) in supervising or directing student teaching, practicums, or site-based programs, 60% said technology was not a factor in placements while 28% said technology was a "minor factor" in the "choice of teachers or schools selected." Another 11% said it was an "important factor" in placements. Only one respondent reported it was "a requirement of most or all placements."

Another question asked about technology-related requirements in student teaching. Of those who answered the question (24%, N=60) three fourths said no requirements involved technology:

75%	None Required
13%	Observe teachers using technology
07%	Support a teacher using technology
02%	Develop a lesson plan that incorporates technology
03%	Teach a lesson using technology
00%	Teach more than 3 lessons using technology

A third question asked if too few technology-using K-12 teachers was a barrier to wider use of information technology in teacher education. Almost four of every five faculty thought that was a barrier. Almost half thought this was an Important, Major, or Extremely Serious barrier. One reason why so few people reported the use of technology was a requirement for student teaching placements may be that the requirement would eliminate the great majority of potential student teaching placements. In spite of the concern expressed by faculty about K-12 teachers, about half said student teachers are required to observe a teacher using technology and 40% said student teachers were required to incorporate technology into at least one lesson they taught.

Summary and Conclusions

Although other data suggests most teacher education faculty make very little use of information technology in their classrooms beyond mentioning technology, they believe information technology is an important, even critical, aspect of both K-12 education and teacher education. The results seem somehow ironic. How can technology be rated by faculty as very important and be so little used in teacher education programs. A possible answer came from a series of in-depth interviews conducted for another part of the OTA-supported research. (Summaries of the interviews are included in the material on the CD-ROM.) Some faculty who participated in the in-depth interviews seemed to separate information technology from other aspects of teacher education such as subject matter content and professional teaching skills. They viewed information technology as a separate type of *content* rather than seeing it as something that should, or could, be integrated into a content course such as an educational psychology course or a methods course. They did not view information technology such as conferencing software, for example, as a way of enhancing instruction in a foundations of education course that deals with critical issues. In addition, they did not see the use of information technology such as collaborative writing software or children's writing and publishing programs as important topics in a methods course on teaching reading and language arts. That perspective allows faculty members to agree that information technology is important but also assert that it should be covered somewhere else in the curriculum other than the courses they teach. The field needs many more models, examples, patterns, and materials that are specifically developed for use in the many and diverse elements of a typical teacher education program - from the Introduction to Teaching course to the support program for novice teachers.

The "it is someone else's job to integrate technology into teacher education" may well be a serious barrier to integration. Another is the feeling on the part of many faculty that they do not have the expertise and experience to use technology for instruction. Information technology is a relatively new aspect of teacher education. In 1985, few programs considered it important enough to do much more than offer stand-alone "computer literacy for teachers" or "educational computing" courses. In 1975 few programs even offered a stand-alone course for teachers. That, however, is the type of environment in which most teacher education faculty received their graduate training. The mean number of years a respondent had been in higher education was just over 15. Thus a person who took a faculty position 15 years ago after completing three years of doctoral work would have been in a doctoral program from 1975 to 1978. In this scenario the average 8 years faculty spent in K-12 education could have been from 1966 to 1974. The 1974-1977 period in higher education, and the years between 1966 and 1974 in K-12 education, were not "high-tech" eras. The great majority of teacher education faculty, in fact, probably completed graduate programs and taught in schools where technology was a minor or nonexistent aspect of education. If they are to become technology-using educators, in-service and staff development opportunities will probably play an important role.

Faculty recognize a need for significant staff development efforts to improve their *educational* information technology skills, but those opportunities are limited on many campuses. Much of the training that is available emphasizes general computing skills, but the need is most severe for topics on information technology integration into teacher education. More support, and more staff development that emphasizes approaches to integrating technology into teacher education (as opposed to training on specific software and hardware) are needed to help the teacher education professoriate become comfortable with technology and learn to effectively integrate it into everyday teaching activities.

A third barrier to the integration of technology across the teacher education curriculum is resources. Teacher education programs are, on average, short on equipment and software for integrating information technology. Programs have generally found money for office computers and the support needed to help faculty use them. However, resources, including equipment, software, faculty time, and support for educational uses of information technology is limited on many campuses. The problem of resources may, however, be an expression of another possible barrier - leadership at the department, college, and university level that does not view technology integration as a high priority. The current political climate, nationally and in most states, suggests there will be no massive infusion of additional funds to equip teacher education programs for the information age. Like the cargo cults of the Pacific, administrators who tell faculty requesting resources for technology integration to write grants are looking in the wrong direction for manna. In the 1990s, the funds needed to adequately equip most colleges of education must come from internal reallocation of resources. Leadership is not in speaking positively about the potential of technology in education, it is finding the ways and means to express some of that potential in teacher education.

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The Current Status of Technology Teacher Education: An International Comparison

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Concern about the training of tomorrow's teachers prompted the USA Congress Office of Technology Assessment to fund surveys of teacher educators and recently qualified teachers during 1993. This paper reports comparisons of an English sample with the American survey. Other papers in this Annual cover the survey of American teacher education faculty (Willis, Willis, Austin, and Colon), and the survey of recent graduates (Colon, Willis, Willis, and Austin). The complete report submitted to OTA is available on the CD-ROM version of the Annual. It includes detailed information on the sampling procedures and the data analysis.

Background

In the UK the particular concern about training tomorrow's teachers to use Information Technology appropriately to enhance learning in the classroom came to a head in the Trotter Report in 1989. The development of IT (information technology) in initial teacher education in the UK from 1982 to 1992 is discussed in more detail in Davis (1992). The anxiety about IT in the UK resulted in a national project called Project INTENT which aimed to develop IT in initial teacher education and to research and disseminate the process (Somekh, 1992).

Concern has also grown in the United States of America. Reports such as the influential *Power On!* published by the Congress Office of Technology Assessment in 1987 pointed to the importance of teachers in the effective use of technology. The research reported in *Power On!* highlighted the critical role of teacher training in efforts to increase the use of technology in school classrooms. The research available to the authors of that report indicated that only limited training was given in most initial teacher education programmes. Many new teachers entered their first year of teaching with very limited knowledge of educational technologies and very little, if any, experience in actually using them to support instruction.

Since 1987 the quantity and quality of Information Technologies such as computers , telecommunication services and multimedia resources available to schools has grown. However, concerns remain about teacher education.

Research in the USA and the UK

As part of an effort to gather research the USA Congress Office of Technology Assessment funded a series of surveys to address the following themes:

- Content of teacher training
- Assistance to student teachers
- Comfort of teacher trainers with new technology
- Access to resources
- Response with certification requirements
- Comparison between the US and the UK

The survey work was led by Jerry Willis from the University of Houston. With his team he developed two surveys. Surveys were sent to a cross section of the university teaching staff and recently qualified teachers. While the university sample included a few IT specialists, they were only viewed as part of the team. The two surveys thus aimed to sample the infusion of IT into courses for pre-service teachers:

- A comprehensive survey focusing on IT use, resources and attitudes of teaching staff was developed. It was mailed to a representative range of teacher education courses in a representative range of institutions.
- A second, smaller survey was developed from the first and sent to recently graduated student teachers in the first two years of their teaching career.

Niki Davis took a parallel sample for each in the England after some adjustments in wording to suit the English context. This paper reviews the comparative aspects of the data.

Overall the English teacher educators and recently qualified teachers seemed more prepared to use IT than their American counterparts. However, there was plenty of room for improvement in both countries. The results from the teacher educators will be discussed before that from the recently qualified teachers.

Teacher Educators

Approximately 10% of the institutions were randomly surveyed in each country in April/May 1993. Ten to fifteen surveys were sent to teacher education institutions, each with the name of a course commonly included in an initial teacher education program. At least one questionnaire was returned from over 60% of the institutions surveyed in both countries. In total there were 250 usable surveys from the USA and 42 from the UK. The courses sampled included both subject courses, such as Postgraduate Secondary Mathematics, and educational and professional studies courses, such as Student Teaching. Educational Computing/ Information Technology was included in the representative sample of courses.

The characteristics of the two populations of teacher educators was similar except that the English staff had taught longer in schools (English mean of 12 years and USA mean of 7 years). Over half of both populations used IT in their teaching with English teacher educators were more likely to use IT in their courses than their USA counterparts (English 85% did use IT, USA 66%). The same trend existed for the estimation of the percentage of their colleagues using IT (English 62% estimated that colleagues did use IT, USA 41%). IT was seen as a course requirement by more staff in England than in the USA (English 76% required, USA 34% required). Fewer required students to develop materials using IT or incorporate IT into lessons (English 34% required, USA 18% required).

In the section of the survey listing more than 50 different types and uses of IT a greater range was indicated by the English. Although the reported patterns of use were similar across the two populations there was a difference of at least ten percent on about ten items - with higher use by English staff in each case. The higher use items included educational games, problem solving software, desk top publishing and video cameras. This held across four categories involving faculty use of the IT resource, requiring students to use the resource, requiring students to create lessons that integrate the IT resource although in the last case only educational games and video cassette recorders were more often used by the English sample.

It is common to find anxiety cited as a reason to explain a reluctance to use Information Technology and also common to find a positive attitude to its use. British responses about computer anxiety and the importance of IT in education were similar to USA responses and in the expected direction. When asked "Do you have some anxiety about using computers (or other IT) yourself or on the courses you teach?" only 3% of the USA surveys reported severe anxiety; 13% moderate, with 34% having some anxiety. Nearly half reported none (44%). Staff did feel that IT was important with the average opinion falling between 'Very Important' and 'Extremely Important' on a five point scale:

Importance of IT in education today	3.93
Importance of IT in teacher education	4.14
Importance of IT in education in 10 years	4.41

American staff used their computer at home more than the English (English: average 6.7 hours; US 9.6 hours) and also more in the office (English average 5.8 hours; US 12 hours). However when asked to rate their current level of expertise more English than Americans classified themselves as 'Advanced' (English 21% ; US 10%). Differences in use were related to more use of US word processors in the office and more US use of telecommunications from home. Comparison of the software staff were prepared to teach with was different on five items by more than 10% with US staff more prepared to use behavioral methods such as; drill and practice, computer-based assessment, computer managed instruction and writing and publishing centers. More English staff were prepared to use problem solving software. It should be noted that apart from 'drill and practice' software, the behavioral tools are only just beginning to be adopted in the UK. A recent national initiative, for example, led by the National Council of Educational Technology emphasizes Integrated learning Systems.

Questions were asked to assess barriers to the use of IT with students. The five point scale ranged from 'Not a barrier' to 'Extremely serious barrier', so that a score of 2 indicates 'Somewhat a barrier' and 3 'Important barrier'. The English consistently perceived a lower barrier on hardware and software issues as shown in Table 1.

Table 1
Average score on 5-point scale of barriers to use of IT

Statement	English	USA
Lack of equipment	2.3	3.1
Instructor/student access	2.0	2.6
Little or no tool software	1.9	2.6
Little or no educational software	1.9	2.9
No software in my content area	1.9	3.0

This conclusion was supported by answers to questions on funding available. More English staff answered that funds were available from the college or school of education (English 48%, US 32%) and from the department (English 55%, US 40%). Indeed more English reported use of departmental funds (English 33%, US 24%). Not surprisingly most resources such as computer labs (English 76%, US 66%) and local area networks (English 29%, US 19%) were reported available in English settings. The only difference in to opposite direction was LCD panels (English 20%, US 31%), but as more English had access to large screen monitors (English 40%, US 30%) that is probably a matter of taste or compatibility with equipment. It is important to note, however, that a quarter of the staff in English programs did not have access to even the most frequently available resource, a computer lab.

Support was also more forthcoming for English staff from the institution's academic computing service (English 81%, US 65%) and for support within the college or School of Education (English 90%, US 70%). The issue of technical support was muddled by the use of graduate students in addition to technical staff in America. Such a job is uncommon in the UK. Opportunities to participate in staff development programs on general computing topics was better for US staff, but the situation reversed when the opportunity was teacher education specific (English 26%, US 16%). However, only a quarter of English staff were offered an opportunity specific to their needs. In addition, while there were more opportunities for support such as staff development, less English staff said there were "rewards or recognition for curricular innovations, software development or other IT applications" (English 12%, US 33%).

Recently Qualified Teachers

Schools across the USA and England were randomly selected and the head teacher was mailed two surveys with a request to pass them on to the most recently qualified teachers. The aim was to survey those who had graduated during the previous two years. This data therefore applied to teacher education programs which are between one and four years older that those reported on by the staff in the previous section. The return rate of useable surveys of only 20% was low, so the results should be considered as tentative: 70 useable surveys constitute the USA sample with 21 from the UK.

The recently qualified teachers were similar in age (average 26 years old) and in years of using computers in courses (average 1 year), but the English teachers had not been teaching as long (English 1.7, US 2.8 years), not using a computer personally so long (English 3.7 years, US 4.2 years), and had a lower percentage of females (English 66%, US 87%). The English used their computer at home for less hours per week (English 5.5, US 6.4) and less at school (English 3.1, US 4.7).

The recently qualified teachers were asked to estimate what percentage of faculty used IT on the courses they taught. A higher percentage was reported by the English (English 53%, US 40%). Almost all the English recent graduates reported that they were " taught with or taught to use IT" within the course programme, whereas only two thirds of US teachers reported this (English 97%, US 64%). The recent graduates were also asked about the use of IT in student teaching. Again there was a clear difference with 80% English participating in the use of IT within student teaching, but only 64% of the US recent graduates. However relatively few reported that technology played a role in the selection of school placements (English 14%, US 4%).

Overall the teacher education programmes were not perceived by the majority of students as preparing them to use IT in their teaching as can be seen in Table 2, although minimal or adequate preparation was perceived by two thirds of the English sample.

Table 2. Recently qualified teachers perception of the preparation to use IT in teaching provided by their initial teacher education course programme.

	English	USA
Not or poorly prepared	34%	52%
Minimally prepared	57%	46%
Well or very well prepared	20%	13%

Discussion

The comparative surveys of teacher educators and recently qualified teachers are unusual in surveying whole course programmes rather than the elements of Information Technology. This relates to recommendations for the infusion of IT into teacher education so that preservice teachers accept it as a means to enhance teaching and learning and see its use modeled for them by teacher educators and mentor teachers during student teaching placements. However, while we recommend that all courses should use IT where appropriate, this does not mean that we would expect to see it occur in 100% of cases. The estimated 65% of colleagues using IT in England is very acceptable for our purposes if it is an accurate assessment of the number of faculty who frequently model use of IT. However, the phrase 'where appropriate' suggests that staff should both feel that IT is important (which they did) and have confidence to use it. Approximately half had some anxiety which must be a cause for concern. In addition improved access to resources, professional development specifically for teacher education, and rewards or recognition must be sought in both England and the USA.

The tentative data from recently qualified teachers was perhaps surprisingly hopeful in England. Almost all recent graduates had been taught to use IT and 80% used it in student teaching. Given the difficulty of access to IT in many subjects in the secondary curriculum in English schools, this is creditable. It provides hope for improvement in the USA which lags behind in most of the areas surveyed (other than some uses of behaviorally-based IT). However, initial teacher education is closely related to current practice in schools where students are placed. It will be necessary to support schools so that student teachers are encouraged to use IT to enhance teaching and learning with the positive attitude found in teacher educators.

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Profiles in Progress: Case Studies of Exemplary Technology and Teacher Education Programs

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MORE INFO
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The Congressional Office of Technology Assessment will present a report to the U.S. Congress in 1995 on the use of technology by teachers. To inform this work we conducted a qualitative, multi-site case study of exemplary preservice and inservice programs that prepare teachers to integrate technology into their teaching. The goals of the project were:

1. to identify several innovative, "state-of-the-art" programs that prepare teachers to use technology;
2. to analyze what can be learned from them; and
3. to outline policy options that might strengthen integration of technology use in teacher training.

The case studies portray different contexts and approaches to preapring and supporting teachers to use educational technology. The sites selected include:

1. Texas Education Agence (TEA)
2. Monterey (CA) Model Technology Schools
3. Jefferson County Public Schools (Louisville, KY)
4. Bellevue (WA) Public Schools
5. Curry School of Education, University of Virginia
6. School of Education, University of Northern Iowa
7. Peabody College, Vanderbilt University
8. School of Education, University of Wyoming

These programs face both similar and different challenges. School district programs must inspire and *re*train the current generation of teachers, many of whom are currently content to teach as they have been teaching, without the intrusion of technology. Colleges of education -- like school districts -- face the challenge of *re*training their own faculty to be competent technology users as well as preparing the*next* generation of teachers. The role of a state in supporting the use of technology in education is more removed from the day to day world of a classroom. Nevertheless, it faces the challenges of establishing a human and an electronic infrastructure that not only exists but *is used* to support and extend teachers' instruction and students' learning.

Despite differences in the populations served and the nature of the specific problems faced, the programs described in this document share a common commitment and face common challenges. All seek to:

1. provide teachers with the vision of a new kind of teaching and student learning enhanced by educational technology;
2. acquire sufficient technology to support this vision; and
3. develop teachers' technical skills and pedagogical visions to a point where they are as comfortable using the new technology in their instruction as they are using chalk, maps, or overhead projectors.

Our goal in these case studies was to tell how each program has developed and responded to these challenges. To collect the needed data, two members of the case study team visited each site for 2 to 4 days to observe training programs, talk with staff, and talk with teachers who have participated in the programs. We also reviewed program documents and evaluations. We then wrote detailed case portraits of each site. These portraits are from 20 to 40 pages in length, and provide examples of course syllabi, evaluation results, and other documentary material. Each case study describes the district or college context, the technology preparation program, the lessons learned by project staff as they have implemented the program with teachers. The case studies also present the reflections of the principal author writing the case study.

The compiled case studies (which appear in the CD-ROM edition of the 1995 Annual) include an introduction to the project and a summary chapter describing the themes emerging across the set of case studies. These cross-cutting themes include (but are not limited to) the following:

1. Begin with a plan -- not just for hardware acquisition, but for helping people learn to use the hardware and integrate technology and instruction;
2. The important training focus is not on hardware operation, but on how educational technology can be used to extend traditional instructional practices;
3. Build local capacity so that support is found in the building, not just in the central office. Work to put yourself out of a job;
4. Start with those ready to go, build local momentum and a critical mass. Concentrate on creating a culture of technology use;
5. Select "trainers" who have people as well as technical skills;
6. Combine local enthusiasm with top-down support; and
7. Email and computer networks are powerful adjuncts to traditional technology training.

We believe the stories of where the programs are now and how they got there may serve as a guide to other institutions that are only now developing their personal vision of the relationship of technology, pedagogy, and instruction, and the strategies they will employ to realize this vision. We hope the stories we provide are useful as governmental agencies deliberate on the type and nature of financial support and policy directions necessary to help bring the vision -- and reality -- of technologically enhanced curriculum and instruction to all of America's colleges and schools.

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THEORY

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The mix of papers in this section make it clear that constructivist theories of teaching and learning, in all their various forms, are popular topics of discussion and application. In their paper, Baumbach, Brewer, and Bird describe the use of anchored instruction as a framework for developing multimedia instruction for teacher education. The focus on constructivism continues in Feng's application of three variations of constructivism to instruction. Fineman and Boootz's use constructivism as a framework for instructional design and Smith-Gratto proposes a combination of behavioral and constructivist approaches in the design of tutorials.

Heide's paper is an example of something that is likely to become much more common in the future: an effort to empirically test theoretical positions related to educational uses of hypertext. Heide's study looked for beneficial effects of advance organizers in hypertext - something that makes good logical sense and has been approached by others from the perspective of the design of information landscapes. The lack of significant effects in the study does not, however, settle the issue. Proponents of hypertext and advance organizers might, for example, question whether Heide's technology - hypertext and advance organizers - matches the underlying theory of the study. That is, was nontraditional instructional material used in a very "traditional" way? Or, were the examples of advance organzers used in the study appropriate and useful? We are a long way from consistent, agreed-upon standards and methods for relating theory, practice, and research on *new media* such as hypermedia and multimedia. As we move from advocacy to application in the area of constructivist theory, many more studies of instructional strategies derived from the theory will be needed.

Although constructivist theories dominated this year's research section, one paper was on a different topic. Harlow, Johnson, and Maddux looked at telecommunications from a philosophical perspective. However, even with this paper the underlying epistemology of telecommunications that is the focus of discussion has much in common with the foundations of constructivism.

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Using Anchored Instruction in Inservice Teacher Education

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MORE INFO
ON CD-ROM

Although the framework of anchored instruction, developed by the Cognition and Technology Group at Vanderbilt (CTGV), can be used in almost any content area, educational technology instructors are finding it to be extremely effective when teaching students how to use a variety of technology tools (Bauer, Ellefson & Hall, 1994). This approach can be defined as an attempt to help students become actively engaged in learning by situating, or anchoring, instruction in interesting and realistic problem solving environments.

The first part of this paper will provide background information about anchored instruction, describe it in some detail, and discuss some of its applications. The second part will describe how the Instructional Technology Resource Center at the University of Central Florida has adapted it to instruct inservice teachers to use a wide variety of advanced multimedia components. The rationale behind the decision to move to this approach will also be discussed.

Background

One goal of the Cognition and Technology Group at Vanderbilt's Learning Technology Center is to help students develop the confidence, skills, and knowledge necessary to solve problems and become independent thinkers and learners (Cognition and Technology Group at Vanderbilt [CTGV], 1990). Most of the education reform literature centers around the failure of traditional instruction to accomplish this goal. The concerns about traditional approaches to instruction have been influenced in part by Whitehead's (1929) discussion of what he termed "inert knowledge." Inert knowledge is the knowledge that can usually be recalled when people are explicitly asked to do so, but is not used spontaneously in problem solving even though it is relevant.

The Cognition and Technology Group at Vanderbilt (CTGV) drew heavily on other early educators. John Dewey, for example, stressed that when people learn new information in the context of meaningful activities, they are more likely to perceive the new information as a tool rather than as an arbitrary set of procedures or facts. Meaningful, problem-oriented approaches to learning are more likely than fact-oriented approaches to overcome inert knowledge problems (CTGV, 1990). Dewey also discussed the advantages of what he called "theme-based learning," and anchored instruction can be used to foster thematic instruction.

Anchored Instruction

The major goal of anchored instruction is to overcome the problem of inert knowledge. Creating environments that permit sustained exploration by students and teachers, enables them to understand the kinds of problems and opportunities that experts in various areas encounter and the knowledge that these experts use as tools (CTGV, 1990). Another goal of anchored instruction is to help students develop representations or mental models of their experiences in order to set the stage for positive transfer (CTGV, 1993).

Researchers at Vanderbilt have found that contexts in visual formats and on videodisc provide effective anchors for the following reasons:

- Visual formats allow students to develop pattern recognition skills.
- Video allows a more vertical representation of events than text; it is dynamic, visual, and spatial; and students can more easily form rich mental models of the problem solving situations.
- Videodiscs have random access capabilities; this allows teachers to almost instantly access information for discussion.

Stages of Anchored Instruction

When using an anchor, the steps or phases of instruction are distinct and sequential, each contributing to the process (Figure 1.) The students are introduced to the anchor in phase one. The anchor might be a video segment which contains a complex problem with embedded data to help solve the problem. In another class, the video content might be rich with information that supports sustained thinking about target concepts or that is needed to comprehend related text and for class discussions. By using a video as an anchor, students and the teacher have a shared learning context (McLarty et al., 1989).

In phase two, students develop shared expertise around the anchor. Multiple visits to specific scenes in the anchor will allow students to develop expertise on particular aspects. In this phase, the teacher might lead a discussion of the anchor. However, as their knowledge of the anchor increases, the students might assume more responsibility for their learning. Once the teacher and the students have developed expertise on the anchor, the links across the curriculum and to their prior experiences become a common occurrence within the classroom.

The students expand the anchor by conducting their own research in phase three. Gaps in information provided by the anchor might require students to research related materials. In an educational technology class, students might learn new technologies using the anchor for content material. For example, the students might create a HyperStudio stack about one of the topics in the anchor.

In phase four, students use their knowledge as tools for problem solving. They might use this knowledge to solve problems posed in the anchor itself or relate the information to problems in other content areas. In this phase, teachers might provide scaffolds to help students solve the problems. For example, teachers who are using the Jasper Woodbury series to teach problem solving and math skills, might encourage the students to determine how to approach the problem and then provide them with the resources necessary to make progress.

Students work on projects related to the anchor in phase five. In this phase, students are given the opportunity to extend their knowledge and relate it to other areas. Some examples of this phase might include reading more about the subject, writing a report or an essay, or creating a multimedia report.

In phase six, students share what they learned from the project. The process of sharing not only creates pride in their own work, but also gives them valuable insight into how their classmates solved the problem. At this point the students are encouraged to compare their solutions with the ones on the video and to evaluate the strengths and weaknesses of each approach.

Phase One:	Introduce the anchor.
Phase Two:	Develop shared experience around the anchor.
Phase Three:	Expand the anchor.
Phase Four:	Use knowledge as tools for problem-solving.
Phase Five:	Work on projects related to anchor.
Phase Six:	Share what was learned.

Figure 1. Stages of anchored instruction.

Once the instructional goals are established, then the anchor can be identified. Prior to teaching with the anchored instruction approach, the teacher must choose an anchor. Anchors should be examined for content and for the amount of structure a teacher must add to the lesson to relate the curricular goals to the anchor. Is the content is too general or too narrow? How much structure will the teacher have to add to the lesson? Does the anchor lend itself to expansion activities? The anchor should provide numerous, rich examples of target concepts that would enable the teacher and students to make links from the movie to multiple contexts across curriculum areas. While the list of considerations for the anchor may be quite lengthy, the critical element in phase one is a clearly articulated set of instructional goals.

Advantages of Anchored Instruction

There are several advantages to organizing instruction around an anchor and then moving to hands-on activities. First, it provides everyone involved with a common background about the subject. Because it is visual, it is easier for students who are not good readers to participate in class discussions. Teachers often find this approach more manageable than finding all the resources necessary to accomplish a community-based project. Students often focus on an issue from a macro context that was not noticed as a potential issue by other members of the class. Once this issue is noticed, further research can be done on it.

Research has found that the use of anchors facilitates communication among students and other community members. For example, anchors can be used to help parents understand what it is like to solve the kinds of complex problems that the students are working on. They might also notice areas where they can supply additional information (CTGV, 1993).

Challenges of Anchored Instruction

The current emphasis on student-centered instruction means that teachers need to change their role from a "provider of information" to a coach and often a fellow learner. Anchored instruction provides one means to make the shift from a teacher-dominated to a learner-centered classroom. With anchored instruction, the teacher can no longer follow a fully scripted lesson plan. Students are encouraged to identify their own questions, goals, and issues that arise as they explore the anchors. Since the students construct their own learning, teachers struggle with how to help the students reconceptualize problems without being overly directive. Another challenge for teachers is how and where to fit anchored instruction into their existing curricula and make sure that it meets their needs with respect to mandated achievement testing (CTGV, 1993).

Applications of Anchored Instruction

This model has been used with students ranging from grades five through college. It has been used in a variety of disciplines: language arts, social studies, math, science, and educational technology. The Cognition and Technology group at Vanderbilt has implemented three projects: the Young Sherlock Holmes project; the Jasper Woodbury series; and the Scientists in Action series.

The Young Sherlock Holmes project, organized around a movie on videodisc, was implemented in two 5th grade classrooms. The students were below average and average in academic ability. The project was designed to help the students learn language arts and social studies content by helping students to observe relevant historical information in movie settings and use their observations to make inferences (Risko, Kinzer, Vye, & Rowe, 1990). This study found:

- The video helped provide motivation and well-defined goals for reading in order to learn.
- Students in the anchored group are much more likely to use newly targeted vocabulary spontaneously than are those in the comparison group.
- Advantages of anchored over non-anchored lessons were found on story writing, vocabulary usage, and the acquisition of relevant knowledge of history (CTGV, 1993).

The Jasper Woodbury series focuses on mathematical problem formulation and problem solving. It also involves the development of applications that will enable students to learn science, history, and literary concepts. Although the series was designed for fifth and sixth graders, it could be used with fourth graders through college freshmen (CTGV, 1989). An important feature of this series is that information needed to solve the problems is embedded in the story. The embedded data design allows teachers to help students try to generate what they need to know, attempt to retrieve this information from memory, and then review segments of the disc to see if they were accurate (CTGV, 1989). The Jasper series provides examples of problems that occur in everyday life and how they might be solved. The Cognition and Technology Group at Vanderbilt also explored the anchored approach to science instruction in their Scientists in Action series.

In another context, The University of Northern Colorado uses this approach in its preservice educational technology course (Bauer, et al., 1994). It was their success in using anchored instruction along with a growing interest in situated learning and perceived weaknesses in existing practices that prompted the writers to explore this alternative approach to inservice education.

Anchored Instruction - Theory into Practice in Inservice Teacher Education

The University of Central Florida's Multimedia Training, Research and Development Center (MMTRDC) is a well-equipped high-tech facility which provides hands-on training for educators in the use of instructional technology (Baumbach, Bird, & Brewer, 1994). Funded by the Florida Department of Education and business partners, the MMTRDC offers one and two day workshops in a train-the-trainers format. The basic MMTRDC workshop, "Jumping into Multimedia" provides participants with skills in working with videodiscs: logging images; using the remote control and barcode reader; creating barcodes for videodiscs; integrating barcodes into text documents; and creating interactive hypermedia programs which access the videodisc. When teachers have mastered the skills in this workshop, they may enroll in the advanced multimedia workshop.

The Advanced Multimedia Workshop for educators, affectionately known among MMTRDC staff as "Drowning in Multimedia," was developed during the winter and introduced in the spring of 1993. This two-day workshop was designed to introduce teachers who were familiar with basic multimedia components, such as computers, videodisc technology and CD-ROMs to more advanced components, such as scanners, video capture, and morphing.

Original Approach

During the morning of the first day participants were given an overview of multimedia hardware and software. The goal of the workshop was to learn to use these tools and demonstrate these new skills through a multimedia presentation at the end of the second day. A matrix was developed which guided the participants, in groups of three or four, through eight workstations over the course of the two days. In fifty minute rotations, the participants moved through the following workstations: video capture, frame grabbing, morphing, scanning, PowerPoint, PhotoCD, My Media Text Workshop, and HyperStudio. Written instructions guided them through the use of the hardware and software at each station. Participants were told that not all of these multimedia components needed to be included in the final presentation.

Some groups, and many individuals within groups, were overwhelmed with these tasks. First, they were learning how to use new hardware and software at each station. Second, they were trying to agree on a presentation topic and sequence which would allow them to demonstrate the application of these new skills. Occasionally group dynamics, and the wide variety of backgrounds and experiences of the participants, made it difficult for the groups to agree upon a topic for their presentation. Too much time was devoted to this aspect of the workshop.

During one session, the lead workshop presenter likened the experience to first shooting a bullet and then drawing a target around it.

Since this diversity in backgrounds and experiences seemed to be the most common problem, it was decided to change the workshop to provide an "anchored" experience for all the participants, so that the time devoted previously to sorting out these differences could be used for more productive activities. In addition, the new format would provide a model of anchored instruction for these teachers and encourage its use in their own classrooms.

Anchored Instruction Approach

The goal of the revised Advanced Multimedia workshop, then, was for each group to solve the problem (and subproblems) presented in the anchor and to use multimedia to present the group's solution at the end of the second day of the workshop. In this way, they were provided with a "target" or goal, so that as they moved through the multimedia workstations they could focus on applying their new skills to that specific project.

The workshop introduced the anchored instruction approach through the use of a PowerPoint presentation followed by the Jasper Woodbury video scenario, "Rescue at Boone's Meadow." As mentioned, the Jasper series focuses on mathematical problem formulation and problem solving. The Rescue at Boone's Meadow scenario was chosen because it represented just enough of a mathematical challenge to make the experience realistic for teachers of all subject areas and grade levels without being so difficult that the less mathematically-inclined participants felt overwhelmed with the content.

After the video was shown, a large group discussion was generated among the participants to begin the process of analyzing the major problem and identifying the subproblems that the small groups would have to solve. A sample multimedia presentation of a solution to another Jasper scenario was shown.

Structurally, the new workshop was similar to the first. Participants were divided into groups of three or four and were guided throughout the two days through a variety of multimedia workstations. Workstations from the earlier workshop that did not directly relate to the problem solving activity were eliminated. Many of the workstations remained the same: video capture, frame grabbing, scanning, and morphing. During these rotations, the groups began capturing and creating images, such as graphics of eagles, ultralight airplanes and other items related to the videodisc scenario, as well as photos and QuickTime movies of themselves that could be used to enhance their presentation.

The CD-ROM workstation was expanded to include not only Photo CD, but CD-ROM clip art and music resources as well as an electronic encyclopedia, which was available for use as a reference source if needed for their solution. A paint workstation (Kid Pix) was added to allow the creation of original artwork. A new FIRN (Florida Information Resources Network)/Internet/telecommunications station served two purposes; 1) e-mail was sent during the workshop to each group giving hints concerning the solution to the Jasper scenario and 2) participants were instructed in the use of Internet searches to find, retrieve and convert graphics or sound files to enhance their presentation.

Three PowerPoint assembly stations were set up for use at any time during the two days rather than at a specific rotation time. This allowed the participants to assemble their graphics and text into a PowerPoint presentation and preview their work as it progressed. Another important addition to the workshop was the use of a brainstorming workstation where the groups could review segments from the Jasper videodisc using barcodes or the remote, discuss their solutions, and plan their presentation. At the end of the second day, each group presented their PowerPoint solution to the Jasper scenario. An example of one group's solution is provided on the CD-ROM edition of this annual as are the handouts for all workstations included in the workshop.

Conclusion

This has proved to be a successful addition to the growing roster of educational multimedia workshops provided by the UCF/DOE Instructional Technology Resource Center. Over 400 teachers have participated in this workshop in both Macintosh and MS-DOS/Windows formats over the past eighteen months and the participants have consistently rated it high in both content and process. The writers feel the use of the anchor for instruction helped to structure the workshop and to provide a realistic context for the use of multimedia. The goal of the Center is to continue to update this workshop as new and appropriate multimedia technologies become available for the educational market; however, it is certain that a video anchor will remain a part of the instructional framework.

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An Epistemological Examination of Computer Telecommunications

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George Gilder in his recent book *Life After Television* (1992) has written of a technological revolution that has far-reaching consequences for our society and its schools. Gilder points to the displacement of television as the dominant medium by the emerging interactive technology. As Neil Postman (1985) has pointed out, television for some years has been the principal medium of our culture, crowding out print and its primary vehicle, the book. Postman rightly holds that each medium conveys an epistemology; that is, a way of knowing and a way of working with the world. The medium in this sense basically shapes the mind.

To Postman, for example, reading promoted rationality. As Postman put it (1985):

> From Erasmus in the sixteenth century to Elizabeth Eisenstein in the twentieth, almost every scholar who has grappled with the question of what reading does to one's habits of mind has concluded that the process encourages rationality; that the sequential propositional character of the written word fosters what Walter Ong calls the analytic management of knowledge. To engage in the written word means to follow a line of thought, which requires considerable powers of classifying, inference making, reasoning. (p. 51)

With the emergence of the television culture the habits of mind turn to an "everpresent tense." The past, therefore, becomes irrelevant and only the present as represented through pictures and sounds are important. Postman (1985) believes that the ability to sustain attention and self-directed thought become casualties with this medium; entertainment and distraction become keenly sought.

In his most recent book *Technopoly* Postman (1993) viewed the competing mind sets in the classroom in dialectical fashion. Postman says:

> It is in the schools where two great technologies confront each other in an uncompromising manner for the control of students minds. On the one hand, there is the world of the printed word with its emphasis on logic, sequence, history, exposition, objectivity, detachment, and discipline. On the other hand, there is the world of television with its emphasis on imagery, narrative, presentness, simultaneity, intimacy, immediate gratification, and quick emotional response (p. 16).

To both Gilder and Postman television is seen as a vertical top-down medium. That is, the viewer is the passive recipient of what the network, cable, or local station provides. The viewer is given a limited number of options and choices, and upon the choosing is placed in a passive role. Power clearly resides at the top, while the viewer is positioned at the bottom. As an educational tool, television therefore limits the power of the student.

Gilder (1993) signals the emerging strength of the interactive medium. Gilder refers to the rise and refinement of the fiber optic network as a medium that will "increase the capability of communication a million-fold or more" (p. 16). The effect of such a technology will be to combine video, audio, and print media in such a way as to permit maximal interaction among a vastly increased base of participants. A salient consequence of this revolutionary technology will be its impact upon the participant. As an educational tool it will encourage the student to be an active knower and creator.

Gilder's idea of this interactive revolution brings to the classroom a power previously unknown to the student. The student is no longer limited to the knowledge base possessed by the teacher. Through the use of the computer and interactive technology the student is in the active position of developing intellectual control. The student will be in touch with fellow learners, texts, and pertinent resources throughout the world. Computer and interactive media will therefore empower the student to reach beyond the classroom to areas of interest and concern. Much like the traditional library, it unlocks worlds and encourages their active exploration.

Postman in his work reminds us that technology has a profound effect upon the mindset of the learner. Gilder's scenario of the interactive revolution would greatly enhance the active and dynamic student's intellect and it would have an equally radical consequence on the relationship between teacher and student. Gilder's notion would cultivate an equality between teacher and student in that both would be seen as fellow learners involved in an interactive quest for increasing knowledge and problem solving. Knowledge would cease to be a monopoly or possession of an elite—whether technological in the case of television or intellectual as in the case of the teacher. Knowledge would be accessible at its source for those prepared to gain it. Dialogue with others with similar interests would be available despite geographical distance. Interactive technology would create in Hannah Arendt's words new "public spaces"; electronic public spaces that would permit voices to reach other voices unconstrained by distance and impelled by curiosity and mutual interest.

The virtues of the print culture would be preserved and enhanced by bringing about a greater access of written texts to the learner. Written works could be enlivened as a part of a living search. Students could for example read Shakespeare interspersed with enactments of scenes from his plays.

In these ways, the potential of the computer and interactive media encourage a transformation in the way we view and experience learning. One constant resides, however, in any effective learning situation regardless of the technology employed; that is, learning begins with a strongly felt engagement in the task at hand. To us interactive technology, by providing learner control, encourages a scene of option and stimulates such engagement.

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Some Thoughts About Applying Constructivist Theories of Learning to Guide Instruction

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This paper addresses two issues: the basic assumptions and characteristics of constructivist theories of learning (CTL), and the circumstances under which it is appropriate or inappropriate to apply them to guide instruction. Constructivist theories of learning grew from cognitive theories which have roots in objectivism, but they reject the objectivist tradition. Objectivism is the philosophical source of behaviorism and most cognitive theories that have guided most educational practice (Winn, 1990; Duffy & Jonassen, 1991). In order to answer questions that may arise around those issues, it is necessary to clarify the differences between objectivism and constructivism. Also, it is necessary to understand the differences among various schools of CTL before drawing on any of them to guide instruction.

Objectivism as the Target of the Constructivist Revolution

Constructivist educators think that objectivism has become inadequate to meet educational needs of today. Behaviorist and most cognitive theories have been nurtured by the Western cultural beliefs and limited by a restrictive set of Western traditional philosophical assumptions (Jonassen, 1991b). Objectivism holds that "the world is completely and correctly structured in terms of entities, properties, and relations" (Duffy & Jonassen, 1991, p. 8), and that knowledge is stable, staying independent of the individual because the essential properties of objects are knowable and relatively unchanging. It assumes that people can gain the same understanding, and this understanding can be completed when rational or "systematic rules are used to draw logical conclusions" (Winograd & Flores, 1986, p. 15).

Behaviorists believe the function of the mind is to mirror an external reality. They think learning is a change in the behavioral dispositions of an organism, and teaching is to provide stimulus-response reinforcement to bring about the change (Jonassen, 1991b; Streibel, 1986). Cognitive science is a revolution to behaviorism in that it acknowledges the mind and its function in learning. However, most cognitive psychologists only recognize the mind as a reference tool to the real world. Learning is more concerned with what learners know and how they acquire it. Therefore, interventions into the mind of a learner must be made so that it can function following a most appropriate sequence of mental activities (Jonassen, 1991b).

Based upon these ideas, educational goals and objectives as well as instructional strategies and learning outcomes are prescribed by teachers or designers. A teacher's responsibility is to map a reality or structure onto the mind of a student by controlling the learning process to progress toward previously determined outcomes. The student's responsibility is to mirror the reality as it is taught. The evaluation of learning is determined by the goals that are pre-organized by the teacher or designer, and is accessed by comparisons to norms (Winn, 1990; Jonassen, 1991b).

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The Basic Assumptions and Characteristics of Constructivist Theories of Learning

Constructivism is generally considered as a viewpoint in learning theory which holds that a person actively constructs his/her own ways of thinking as a result of innate capacities interacting with his/her experience (Molenda, 1991). Constructivist learning theories grew from cognitive theories, but they reject the objectivist tradition (Jonassen, 1991b). This may suggest new paradigm shift in the field of learning. "It can be seen as an end of the cognitive psychologists' emphasis on students' internal representations of external phenomena, and the pivotal role assigned to the cognitive processing of those phenomena" (Tobias, 1991, p. 41).

Opposite to the objectivist emphasis on *object*, constructivists are more concerned with how people *construct* knowledge (Jonassen, 19991a, 1991b). But they do not necessarily have the same assumptions about knowledge construction. There is a degree of consensus among them that reality is more in the mind of the knower who constructs or interprets a reality based upon individual perceptions. They hold the same epistemological concept that meaning is a product of an individual's creation from personal experiences, yet they have different considerations about the validity of the constructed knowledge. They recommend different approaches to teaching and learning based on their different assumptions, but they share many thoughts about learning evaluation (which will be discussed later).

There are three types of constructivists according to their different points of view. The first type I call *radical* with an emphasis on subjectivity or the absolute impossibility of being objective and, in the extreme, even a rejection of realism (Goodman, 1984; Winograd & Flores, 1986; Molenda, 1991). The second type is *moderate* in that it acknowledges that there is a realism in which there are enough spaces for people to construct their own understanding of the world (Cognition and Technology Group at Vanderbilt, 1991). The third type is *rational.* This type recognizes the dynamic nature of learning or the mediation of new knowledge by old during the interpretation-reflection process (Winn, 1991).

The Radical Constructivist Point of View

Radical constructivists believe that "What we *know* to be real is the result of historical and social processes of meaning-making, language-making, and symbol-system making. This social construction of reality applies to our knowledge of physical reality as well as to our knowledge of social reality" (Streibel, 1986, p. 138). It is acceptable to have a reality that is different from that viewed by others. Knowledge depends on the way people look at the world. "There are many ways to structure the world, and there are many meanings or perspectives for any event or concept. There is not a correct meaning that we are striving for" (Duffy & Jonassen, 1991, p. 8). Radical constructivists emphasize that understanding is tracked by experience, and that schools should provide cognitive experiences from which students can build their understanding of realities. The responsibility of an instructor is to coach students who serve *cognitive apprenticeship* (Jonassen, 1991b, p. 11). The center of the whole learning process, students are given the freedom, as well as, the responsibility to decide what and how to learn (Perkins, 1991).

The Moderate Constructivist Point of View

Moderate constructivists think that there are structures in the world, physical and epistemological, that place constraints on knowing. They come largely from the community of which one is a member. Nevertheless, there are "sufficient degrees of freedom in the structure of physical and epistemological worlds to allow people to construct their own personal theories of their environments" (Cognition and Technology Group at Vanderbilt, 1991, p. 16). They think that the mind is instrumental and essential in interpreting events, objects, and perspectives on the real world. They believe that "knowledge is a dialectical process the essence of which is that individuals have opportunities to test their constructed ideas on others, persuade others of the virtue of their thinking, and be persuaded" (Cognition and Technology Group at Vanderbilt, 1991, p. 16). Therefore, schools and teachers must build a learning environment to capitalize on a student's extensive ability to create interpretations of the world. Students should be encouraged to develop socially acceptable systems to explore new ideas and differences among people, and to be able to "appreciate good rules, good theory, good science, good debate, etc" (Cognition and Technology Group at Vanderbilt, 1991, p. 16).

The Rational Constructivist Points of View

The rational constructivists share a similar understanding of reality with the moderate constructivists. What distinguishes them from the radical and moderate constructivists is their recognition of the dynamic nature of learning, the impossibility of predicting how students will learn, the understanding that knowledge is an ever-changing process, and the weakness of being *anti-empirical* in human cognition. They acknowledge that students are active participants in their own knowledge creation by plugging new information into their existing schema, and by interpreting and organizing it into meaningful patterns. They warn that the knowledge transmitted may not be what is constructed by the learner due to the autonomous nature of the mind in the management of knowledge construction. They suggest that curricular and instructional decisions be made by teachers when it is impractical for students to take the responsibility. The responsibilities of instructors are to guide students in their knowledge construction, and provide concrete teaching whenever necessary. Students are at the center of the learning process with responsibility to decide what and how to learn. However, this model is considered more appropriate for ill-structured domains or higher-level learning (Cognition and Technology Group at Vanderbilt, 1991; Winn, 1991).

Alternative approaches to learning evaluation are proposed especially by the moderate and more rational constructivists. Assessment methods evaluate the outcomes of a learning process. Authentic task evaluation allows students to select tasks that are meaningful for them. Knowledge construction focuses on learning outcomes which reflect the intellectual processes of knowledge construction and entail higher-order thinking. The multiple perspectives method makes references to a domain of possible outcomes as acceptable evidences of learning. Other methods are the experiential constructions method, context-driven evaluation, learning context-dependent evaluation, multimodal method, and socially-constructed meaning method (Jonassen, 1991a).

Appropriately Applying Constructivist Theories to Guide Instruction

My Understanding of Reality

I am conservative about the overradical assertion that there is no shared reality. I believe there are external realities, some of which are stable. For instance, a river is a (relatively) stable reality as is a language; the weather is an unstable reality as is a society to an individual. It is characteristic of human beings to keep inquiring, creating, or changing a reality. Reality is shareable and needs to be shared. All inquiries in physical and social sciences have been aimed at understanding and sharing reality. We share realities because we share a *public space* in our minds where there are shared meanings and symbol systems such as history, language, religion, and values (Streibel, 1986).

Human beings share basic realities such as the physical world and psychological needs. Upon these basic realities we develop higher-order, but common, realities such as languages, values, symbol systems, and cultures with whatever is available or provided by the nature (Streibel, 1986; Reigeluth, 1991). We do have differences. For instance, a Western bride wears a white gown but a Chinese bride wears red gown. Realities are limited by, or composed of, various factors - time, space, cultural, and/or social-environmental conditions - and are subject to change. We use different symbol systems to communicate within and between cultures. This communication is decided by the similarities in human intellectual-psychological development across cultural groups. For instance, math symbols and values are universally shared, which makes it possible to present a math problem in different languages without changing the original meaning. We translate literature across languages because there is a "public space" in our mind of shared feelings.

My Attitude Towards Constructivism

I think I am a constructivist following the "rational group," but I am not ready to reject all objectivistic ideas. Objectivism and constructivism represent alternative conceptions of reality, knowledge, and learning, existing at the two poles of a continuum from externally mediated reality to internally mediated reality (Jonassen, 1991b). Leaving them decontexted, none of them could be more valid than others. I do not think that anyone can be completely objective or subjective in the learning process. When observing an event and communicating it to others, the observer has to start the observation from his or her own standpoint. The subjectivism is reduced, however, when the observer starts to communicate and share understanding with others who do not necessarily have the same ideas. The terms "negotiated knowledge" and "shared reality" to me indicate compromise between objectivism and subjectivism.

Appropriately Applying Constructivist Theories to Guide Instruction

From my point of view, there are three principles of constructivism that fit all levels of instruction in all fields: (1) teachers must teach from where the students are, (2) they must build a supportive learning environment to capitalize on students' extensive ability to construct knowledge, and (3) they must have the power and strength to make instructional decisions based on students' changing needs.

The view that "there is neither a single reality nor an objective entity" may be problematic for all levels of instruction in all fields. This claim precludes any possibility of, or the need for, communication. There would be no society if there were no need for people to negotiate or share a reality. Many constructivist theories are inappropriate for entry-level learning. At entry-level students do not have the preparation for decision making on what and how they should learn. The educational goals, objectives, contents, and even learning methods have to be decided under close supervision of the teachers. Concrete teaching is necessary before students attain basic knowledge and skills to make free exploration. The teacher's control may be gradually reduced at higher grade levels. This does not mean, however, that students can take the entire responsibility for what and how to learn from the very beginning (Perkins, 1991; Winn, 1991).

I can not see the need for students to go through a trial process to assemble knowledge in well-structured domains (Spiro, Feltovich, Jacobson, & Coulson, 1991), such as mathematics, physics, and chemistry, especially at elementary and secondary levels of learning. It is unnecessary for students to look for a way to prove why the sum of the three interior angles of a triangle must be 180 degrees but not anything else. It is impossible for any individual to experience all the knowledge s/he needs to learn that has been accumulated throughout history. Also, it is unacceptable for students to create their own criteria or realities all the time. For example, the English grammar rules can not be changed arbitrarily by any individual, since grammar is a relatively well-structured domain and its established rules need to be respected for communication.

Instruction is not totally dispensable even at higher-levels of learning. For instance, it is unrealistic to require a first-year student in a teacher education program to choose a pedagogic philosophy to guide his or her future professional engagement before s/he knows what the varieties of selections are. It is also impractical to expect that this student make choices by himself or herself in a short period of time while struggling with other course requirements or a job. If students were thrown into a sea of resources with the freedom to "sink" or "swim", many of them would drown before they were able to reach the shore. In the contemporary information jungle, students may get lost in management without any experience to guide them through (Perkins, 1991).

Most of constructivist theories are applicable for graduate, vocational and professional education, and instruction in ill-structured domains. At the level of advanced learning, students are psychologically and academically mature enough for highly independent inquiries. They need to master complexity and acquire the ability to apply and transfer knowledge to a wide range of new or real-world situations (Spiro, Feltovich, Jacobson, & Coulson, 1991).

Many instructional strategies and methods recommended by the moderate and rational constructivists are useful for vocational and professional training, such as apprenticeship, coaching, and situated cognitive experiences. In these fields students should take much of the responsibility for what and how to learn. Instructors should provide concrete guidance whenever necessary. However, the evaluation of learning outcomes should follow socially acceptable norms in most cases. For instance, students in a highway traffic control program would not be allowed to have their own criteria which were different from what were accepted by the society. It is also unthinkable that a pharmacist's knowledge about dosage could be different from that of a doctor's.

Most of constructivist theories have significant value for instruction in ill-structured domains such as literature, history, and political science. In these domains a limited explanation (or one-sided understanding) of what is "correct" may miss too much of the complexity that must be mastered before a socially acceptable answer is located. For instance, some Americans "interpret the wars in Vietnam, Granada, and Iraq as the obligation of a democratic state to defend the rights of nations oppressed by the evils of communism or dictatorships; others believe these wars represent the avaricious protection of the rights of multinational corporations to perpetuate a decadent life-style" (Jonassen, 1991b, p. 10). In such cases, it is not easy to say how correct either view is. Teachers should avoid oversimplifying instruction. Instead they should provide students multiple representations or perspectives so that students can explore several alternatives before they build up their own understanding.

To end this paper, I am suggesting that constructivism be included in the required readings of educational philosophy for teacher education and graduate education. It is a new philosophy of understanding which "comprises a philosophy of science, a philosophy of art, as well as a philosophy of cognition" (Jonassen, 1991b, p. 10), presenting anti-traditional and alternative conceptions on teaching and learning. It encourages multiple perspectives of the world and diverse ways of thinking. This in turn will have a positive influence on their students' intellectual development. Unless educators have had such preparation in their own education, it is unreasonable to expect them to display constructivist virtues to their students.

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An Introduction to Constructivism in Instructional Design

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The purpose of our paper is to contribute to the reader's understanding of constructivistic learning. Recently, constructivism has challenged more traditionally held views concerning the objective nature of instruction. This new theory of learning yields fresh insights and poses unresolved problems. As such, it is important to engage educational practitioners in discourse that can shape and influence the structure and application of constructivism in educational settings.

We begin by discussing the theoretical milieu of constructivism. We then briefly describe the components of constructivism and provide an example of a learning environment which embodies our understanding of these concepts.

Constructivism is one theory among many from a variety of disciplines that calls for us to question our ontological and epistemological assumptions. Constructivism, in our context, is an offshoot of cognitive psychology and represents a recent learning theory. However, constructivism is also a term used to describe an art movement that emerged from the ashes of cubism and by the artistic search for the visual expression of new realities - realities resulting from early twentieth century discoveries in science that altered conceptions of natural law. The impact of these discoveries is evident in the words of Kandinsky: "The disintegration of the atom was to me like the disintegration of the whole world" (quoted in Nash, 1985).

Similarly, other disciplines have been affected by an evolving zeitgeist of post-modernism. Arguments concerning quantitative versus qualitative research methodologies have raged with each representing a distinct world view. Often, these world views are viewed as opposites that call into question the other view's fundamental epistemological and ontological positions.

For example, Lincoln and Guba (1985) reject positivistic views about the world (particularly positivist views of human nature) that have provided the foundation for quantitative research methodologies applied to the human sciences. In their support of qualitative, naturalistic inquiry they denounce claims of an objective reality, repudiate the idea of cause and effect, and disavow the pretense of objective inquiry. Naturalistic inquiry embraces an alternative set of beliefs and a research methodology arises explicitly from these beliefs. These beliefs include, among others, a belief in multiple constructions of reality (as opposed to belief in a single and objective reality), mutual simultaneous shaping with the actor and the acted upon affecting each other (as opposed to cause and effect), and subjective inquiry or the idea that the researcher can not remove his/her biases from the research study pursued (Lincoln & Guba, 1985).

Research methodologies chosen are a direct reflection of a thoughtful researcher's epistemology and epistemologies are evolving. Polkinghorne (1983) describes a transition in our conception of the term "truth." Truth, he maintains, is no longer conceived of as *apodictic* - irrefutable and certain knowledge. Rather, he believes truth is presently under-

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stood to be *assertoric* meaning that it represents the best understanding we have and can communally agree upon given the evidence that is currently available.

This change in the stature of "truth" is also evidenced by the increasing acceptance and expression of "alternative" viewpoints such as those representing women, minorities, and other groups who desire to have their perspectives voiced and considered.

This era of change has surfaced in many disciplines including art, research, epistemology, hermeneutics, and linguistics, among others. It's only natural that this current should be reflected in our understanding of learning and in our approach to instruction.

"Constructivism is at once a theory of 'knowing' and a theory about 'coming to know'" (Fosnot, 1992). As such, its implications for instruction and understanding how learners construct meaning are profound. Constructivists vary greatly in their understanding, selection, and interpretation of how to apply constructivism. Nevertheless, the most commonly agreed upon tenets of constructivism will be described below.

Constructivism emphasizes the importance of the learner's active engagement during the learning process. The learner *constructs* or generates meaning from his/her experiences rather than passively receiving *knowledge* from the teacher. Constructivist views shift the locus of knowledge from a source external to the learner to a place resident within the learner. That is, constructivists believe that knowledge is not freestanding and context independent. They hold that knowledge is personally constructed through an individual's interactions with his/her environment. Instruction can facilitate the process, but instruction does not result in a transfer of knowledge. Only the learner can build meaning and increase his/her knowledge through the learning process. The content domain may be prespecified, however what the student chooses to learn cannot be predetermined. Learning should aspire to inform students in how to approach the problem solving process or how to think like a subject matter expert - actually, as a user of the data, rather than as a repository for the data.

Collaboration among learners is critical because it is important to recognitize each learner's unique perspective and to support the social negotiation of meaning. When learners dialogue, each learner is exposed to multiple perspectives in the environment. The learner therefore deepens his/her understanding through interacting with others in the environment. Once again, the emphasis is on constructing meaning rather than acquiring and processing knowledge.

The role of the teacher in a constructivist learning environment shifts from that of an authority figure to that of a mentor figure. Since knowledge is no longer believed to be transmitted from the teacher to the learner, and knowledge construction becomes the responsibility of the learner, the teacher therefore assumes the role of a learning facilitator. One way in which facilitation can occur is by modeling the use of tools in a manner similar to that which exists in the relationship between a master and an apprentice.

As alluded to previously, constructivists embrace a great range of ideas and theoretical stances (Winn, 1993). A description of common constructivist elements may misrepresent the positions of some and fail to mention attributes of significance to others. Therefore, descriptions of applied constructivism, or of *postmodern learning environments* are beneficial in that they elucidate the constructivists' beliefs about learning and enable more informed dialogue about ideas to ensue. What follows is our formulation of a learning environment built upon our understanding of constructivist principles and currently being used on a trial basis at the University of Texas.

Overview

The purpose of our poetry learning environment is to provide students the opportunity to appreciate, value, and enjoy the artistry of words - poetry. We like to think that exploration within our environment could foster in some students the desire to further their acquisition of connoisseurship regarding poetry. One of the ways in which the environment seeks to help students accomplish this is by guiding students in the transfer of their already developed sense of appreciation and connoisseurship (in an area of their interest) to perhaps the less familiar subject area of poetry.

The learning environment resists being bounded by a description that too heavily demarcates what the environment is and isn't - or includes and excludes. Describing it nonetheless, the centerpiece of our post-modern learning environment (PLE) is the student and a computer program loaded onto either a stand-alone computer or local area network. This computer program can be considered the students' "drawing board" in the sense that this is where they will return for guidance (in the form of suggestions for gathering information, questions to direct thinking, and so on) and composition (entering poetry, responding to questions, reconstructing poems, and so on) throughout the process of experiencing poetry.

It is our hope that the loose framework of our PLE is dynamic and flexible enough to accommodate divergent interests that students have in regard to learning about poetry. In other words, the PLE structure exists not to prescribe the knowledge content that students will acquire but to allow the student to assemble information about aspects of poetry of interest to the student. In this sense, the learning is self-directed.

Elements of the Environment

Our PLE consists of resources, participants, and activities. As stated earlier, the centerpiece is a HyperCard program called *Cabaret Voltaire* that was programmed by Mark Cristal at the University of Texas. Following World War I, the Cabaret Voltaire was a cafe in Zurich where artists, poets, and philosophers gathered for lively discussion and debate concerning the politics and the Zeitgeist of the times. The artistic movement spawned in this meeting place, and others similar to it in New York and Paris, is called Dadaism. The concept guiding the design of our software was to simulate a society of poets where thought-provoking discussion can occur by students interacting virtually with the other poets, philosophers, and students whose poetry, thoughts, and questions become a part of Voltaire.

Upon entering Voltaire, students enter their name in the guest book and become a member of a most exclusive club. After initial log on, they are presented with a brief description of the concept behind and the capabilities within Voltaire. They then approach the main screen in Voltaire and have their choice of several options. They can write a poem, add poetry from a poet (other than themselves), see a poet's work, or make a "SIMP".

The term "SIMP" connotes a "simulated" poet. Voltaire gives students the option of randomly composing poetry from the works of three different poets (selected by the student) using a computer program called Travesty. Use of Travesty requires the students, with the help of a facilitator, to select three poets and copy their poetry from Voltaire to a diskette. This poetry is then added to the simulated poetry category and is available for reading as is all other poetry within Voltaire. The simulated poetry can be considered a collage of other poet's work.

If students choose to see a poet's work, they have their choice of selecting poetry from a poet of the past (e.g., Yeats or Pound), from a Cabaret Voltaire poet (i.e., other students), or from a SIMP. After selecting a poet, his or her poems appear on the screen. The students highlight a poem and then can either read the poem or discuss one of the poet's works. Additionally, they can enter more of the poet's poems into Voltaire.

For example, if a student elects to discuss a poem, her or she must then select a discussant. This is when the cabaret atmosphere is most simulated. The student will find that Voltaire contains *characters* - each with a different ideology, philosophy, or perspective (e.g., Marxism, Feminism) that causes them to react differently and brings a different set of biases and assumptions to poetry. Students find out more about each character by reading a character's description. Having selected a character, the student then encounters the questions about the poem that character challenges the student to answer. Voltaire is populated by characters whose questions span the range of complexity from novice to expert. Voltaire enables students to view the questions, their responses, and the poem all on one screen.

The questions are intended to assist the student in analyzing poetry from various perspectives. Additionally, students' interaction with the characters is intended to improve their ability to articulate their thoughts, feelings, and reactions to the poetry.

Other features of Voltaire help students compose their poetry and/or enter a character and questions for poetry analysis that other students can access.

Participants within Voltaire include the student, other students, and a metacognitive facilitator. Collaboration is strongly encouraged as is participation in and with a variety of activities and resources.

We feel that the metacognitive facilitator is a crucial and essential component of the poetry PLE. The facilitator contributes to the student's learning experience by assisting the student's processing (i.e., analysis and synthesis) of her/his experience (e.g., by offering questions and suggestions). The facilitator dialogues with the students during what we term metacognitive sessions.

The dialogue in the sessions consists of questions offered to the student to guide his/her further exploration of material relevant to selected path(s) of interest. This interaction is designed to help the student develop self-awareness by reflecting on his/her learning. The facilitator augments this reflection by suggesting or exposing the student to potential and additional opportunities for learning. Examples of the facilitator's metacognitive guidance include:

1. Think of an artistic, scientific, creative or constructive medium you feel you understand such as movies, woodworking, or cooking. Think of the criteria you use for judging this medium.
2. Based on your knowledge of your chosen medium, brainstorm criteria and/or relationships between criteria you could use to judge this poem.
3. Try to apply one of your criteria from your brainstorming to this poem. Tell me about the relationship you've built from this criteria to the poem.
4. What would you like to know about poetry in general? In terms of this poem? This poet?
5. Why is this information important to you? How would you find this information?
6. Go find this information, and see me in two weeks.

We believe students will benefit most from these questions through interaction and discussion with the facilitator. However, this question set is also available on Voltaire to provide a flexible framework for the student's path of learning.

We feel these questions are essential to the higher-level cognition and meaningful engagement of the student with the poetry text.

The environment, in its expanded state, could also consist of an index to additional sources of information about poetry (resources) and activities. Index examples could be as follows:

1. Use of Internet can direct students to a variety of on-line environments which revolve around poetry. Some of these sites allow students to find poetry by author, title, and topic; to join a news group to discuss poetry; and to learn about poetry-related projects and events.
2. Granger's Poetry Index, available on CD-ROM, allows students to search its database for poetry by author, title, and topic. Cites are provided to anthologies or poetry collections and the texts of some poems are provided.
3. The environment also contains books such as poetry anthologies, complete works of certain poets, poems from a variety of languages (both translated and in the original). Books and magazines could also be made available to the students as a source of poetry. Books

oncritical analysis of poetry expose the students to different types of critical thought such as feminism, Marxism, and historical analysis.

4. An audiobooth could also be included in the PLE to allow students to hear the poetry read by the poet or interpretively by others.

Nature of Learning

The PLE invites a broad, flexible learning because of the nature of the content. For example, poetry can stimulate students to learn about philosophical, psychological, affective, attitudinal, historical, political, literary, and rhythmic issues. The PLE supports the acquisition of simple to advanced concepts within various ill-structured domains.

From the Student's Perspectives

Our intention is for students participating in our PLE to exhibit a high degree of activity and initiative as a result of the stimulating environment It is our hope that students' experience in the PLE will help them sense the poetry extant in their natural environment. We don't conceive their PLE experience to be unnaturally or artificially separate from the students' environments. To better understand our views, imagine our PLE in a mall, in a gallery on a street, at the airport, or in a cafe.

Learning Meter

As stated earlier, the learning goals and content students encounter within the PLE are not prescribed. Therefore, alternative measures for describing students' learning need to be pursued. These alternative measures include on-going self-reflection recorded in either a journal or a taped conversation (with self or others). At the end of a series of interactions with the PLE, the student will have a choice of using a variety of techniques to assist in their analysis, synthesis, and expression of their learning. Some examples of these techniques could be a paper, a photo essay, a Hypercard stack, or poetry. The facilitator's interest in the journals and learning *products* will be to detect evidence of the student's reflection upon his/her learning. Such reflection could be demonstrated in the student's description of new patterns he/she learned, questions answered, and new questions raised.

Connections to Constructivism

We feel the design of our PLE conforms to commonly held beliefs concerning constructivist learning. These beliefs, most simply stated, dignify the learner's ability to construct meaning for him/herself given a rich enough environment. Specifically, we feel the PLE accommodates multiple learning styles by offering various learning activities such as writing, reading, and listening. The availability of these activities, we hope, may encourage people to dabble in learning activities other than those they already favor.

The student controls the learning experience by selecting both the content to study and the goals for his/her study. For example, the student will determine which poets, which type of poetry, which aspects of the poet/poetry to study. The overall aim of the PLE is to engage students in developing an appreciation for the poetry. Therefore, allowing the student to pursue a path of interest to him/her within the domain of poetry is of paramount importance.

Collaboration serves as the primary vehicle for fostering the ability to view an object such as a poem from multiple perspectives. Students will collaborate with other students and the facilitator. Additionally, students will collaborate with the various characters issuing the question sets within Voltaire. Use of the various question sets concomitantly challenges the student to view the same poem from various and diverse perspectives as well as shift the emphasis to different aspects of the poem. Obviously a Feminist perspective differs from that of a Marxist.

Use of the journal, recording, and metacognitive facilitator can assist the learner to both reflect on and express his/her emerging understanding of, and involvement with the poetry. Metacognition is also a skill that aids in the connoisseur's critique of poetry. In addition, the poetry connoisseur must develop sensitivities to sound, images, and meaning evoked by words and the ability to relate their own intense feelings and intimate experiences to the written page. We hope that the continued exposure to poetry in its many forms as well as the opportunity to discuss the poetry with others will allow the students access to these parts of themselves.

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Cognitive Structuring of a Historical Event Read from Computer Hypertext

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As technology with greater power and greater facility has been developed, new ways to use computers in instruction and learning have become possible. One outcome of this development, for example, has been the capacity for accessing information in non-sequential writing or hypertext.

Jonassen (1988) and Marchionini (1988) saw the instrucational potential of computer hypertext and Bevilacqua (1989) predicted that it would probably change our way of thinking. On the other hand, Smith (1987) cautioned that although hypertext offered many new opportunities, there are also many questions about its effective use in learning situations.

Computer hypertext consists of a number of individual nodes of information linked together in a web-like structure. Hypertext readers can move from one node to any one of a number of other information nodes linked to it. One of the first recognized benefits of computer hypertext was the users' freedom to move among nodes of information guided by their own mental associations.

One of the disadvantages first noted in computer hypertexts, however, was the danger of information chaos caused by the absence of predetermined conceptual linkages of the sort traditionally employed in linear text writing. An important part of learning is identifying the relationships between ideas and thus mastering higher-order concepts. In a traditionally written text, new concepts are illustrated by a sequence of supporting or related ideas and by specific words that indicate relationships. In linear computer-assisted instruction programs, learners are directed through the script. In the absence of that fixed sequence of information, hypertext readers can sequence the content of a document idiosyncratically. How they then structure or conceptualize the new information gained through self-directed navigation raises concern about the use of hypertexts for school instruction. When students link new content to established ideas they perceive to be relevant to the incoming information, it is possible for them to network this new information in ways that produce misconceptions.

Learning and Assessment Strategies for Hypertext Documents

One strategy that has long been used with linear text to help students assimilate new information accurately is the advance organizer. The purpose of this study, therefore, was to determine whether cognitive structuring of new information gained from a computer hypertext could be mediated by an advance organizer. The purpose of this advance organizer was to provide the students with an ideational framework to help them conceptualize the information fragments in a computer hypertext. The researcher hypothesized that the insertion of an advance organizer at the initial point of access to a hypertext document would guide secondary school students' cognitive structuring of complex concepts. Finding a way to assess cognitive structures, however, was of particular concern.

During the 1980's when computer hypertexts proliferated, concept mapping also became a frequent subject for research and development. Most studies of knowledge organization were conducted in the well-structured fields of mathematics and science. Most investigated how concepts within a topic are related to each other or what changes take place in an individual's cognitive structure as a result of instruction. Similar studies of how students organize information in an ill-structured (complex and irregular) domain such as social studies are lacking.

Many studies (Champagne and Klopfer, 1980: Harty, Jamrick, and Samuel, 1985; Rogan, 1988) indicate that student concept structures can be assessed by comparison with knowledge structures drawn or composed by content experts. All were done in traditional paper and pencil format, but in 1989 Tsai-Ping Ju at the University of Pittsburgh designed *MicroCAM*, a computerized measurement tool to measure the three parts to a knowledge structure — concepts, connections and relationships — in various content areas. Because it was simpler to use, *Learning Tool*, a commercial computer program for constructing concept maps, was selected for use in assessment in this study.

Method

A 2 x 2 factorial study with repeated measures was conducted with 70 tenth-grade American History students. Subjects were assigned to two groups by stratified random sampling. A control group in each of four classrooms of students, two honors level classes and two regular classes, received only a commercial computer hypertext as it is published; an experimental group in each of the same four classrooms received the same computerized material with the addition of an advance organizer.

The independent variable was the advance organizer; the dependent variables were scores on an objective achievement test and assessments of subjects' pre- and post-instructional concept maps, constructed with *Learning Tool*. The experimental groups in each class were used *The Election of 1912* with the advance organizer, whereas the control groups received the program as regularly published. A criterion concept map and an objective test were constructed by the teachers of the classes.

Knowledge Structures

The subject matter teachers' knowledge structure of the content, displayed in a concept map with *Learning Tool*, was the criterion to which students' knowledge structures, also displayed via concept maps, were compared. Pretest and posttest concept maps were assessed according to the degree of consistency (percent agreement) with the criterion concept map composed by their teachers, a procedure demonstrated in the studies by Harty, Jamrick, and Samuel (1985), Ju (1989), and Rogan (1988). The increase in the degree of consistency (with the criterion concept map) between individuals' pretest and posttest concept maps was calculated. The increase in the degree of consistency in the experimental group of students' posttest concept maps and that of the control group of students' posttest concept maps were compared. Last, the increase in the degree of consistency in the honors students' posttest concept maps and that of the regular students' posttest concept maps were compared.

Results

In a two-way analysis of variance on the achievement test, no significant difference was shown between the experimental group and the control group ($F = .46$, $p = .50$). This finding indicates that students who read an advance organizer before reading the hypertext did *not* score higher on an objective achievement test than students who had not read an advance organizer.

An analysis of variance on the degree of consistency between student and teacher-constructed matrices indicated a significant effect for Time — pretest to posttest — ($F = 33.31$, $p < 001$) and for Class ($F = 30.14$, $p < .001$). The overall means for the experimental group were 71.67%, and the overall means for the control group were 69.35%.

There is some evidence that the posttest knowledge structures of students who read information from a computer hypertext did become more consistent with the knowledge structure of subject matter experts than the students' pretest knowledge structures. The posttest knowledge structures of all subgroups (Experimental Honors, Control Honors, Experimental Regular and Control Regular) did become more consistent with the knowledge structures of subject matter experts (teachers). The relationship statements in the posttest knowledge structures of three subgroups (Experimental Honors, Experimental Regular, and Control Honors) did become more consistent with the relationship statements in the knowledge structures of subject matter experts. The relationships statements in the posttest knowledge structures of the Control Regular subgroup, however, became less consistent with the subject matter experts' structures than they were in the pretest.

The posttest knowledge structures of students who read an advance organizer before reading information from a computer hypertext did not become more consistent with the knowledge structure of subject matter experts than the posttest knowledge structures of students who did not read an advance organizer. No statistically significant difference was found between the experimental group and the control group on this factor.

The posttest knowledge structures of honors students who read a computer hypertext did become more consistent with the knowledge structure of subject matter experts than did the posttest knowledge structures of regular students who read the hypertext. With respect to knowledge structure correspondence, both the pretest means and the posttest means for the two Honors subgroups exceeded the respective means of the two regular subgroups. A significant difference ($F = 19.02$, $p < 0.001$) was found between the honors students and regular students in respect to relationships stated. Summing across pretest and posttest, honors students' statements of relationship were more consistent with the subject matter experts' statements of relationship than were the regular students' statements of relationship.

Discussion

Spiro (1991) claims that his Cognitive Flexibility Theory supports the use of hypertext in an ill-structured domain because it promotes "criss-crossing" the landscape of information. By approaching a bit of information from a different direction than they came to it previously, students should be able to connect that bit of information in more than one context. How they connect or relate bits of information to each other in a knowledge structure can be manifested through concept mapping. When students arrange the nodes of information spatially and form relational links between the nodes, the relationships they perceive between concepts and the contexts into which they place these concepts can be assessed.

Nitko (1989) proposes that tests of learning focus on the way a student perceives the structure of the content. Boud (1990) concludes:

> Learners must make their own maps of knowledge. At times they can benefit from seeing how others have constructed maps of their own, but ultimately they will only be able to use with facility that which they have put together themselves. Only the learner can learn, and only learners can imbue knowledge with personal meaning and use it in their lives. (p. 6)

This viewpoint appears to contrast with that of Jonassen (1990):

> Eliciting semantic networks from a subject matter expert using any of the tools described above [*Learning Tool* and *SemNet*] represents an approach to structuring hypertext. This approach assumes that the hypertext structure should reflect the expert's knowledge structure because it can be mapped (to some degree) on the learner's knowledge structure. (p. 148)

Both viewpoints, however, support an aspect of constructivist learning theory that "meaning for material presented by computers or any other medium is generated by activating and altering existing knowledge structures in order to interpret what is presented" (Jonassen, 1988, p. 154).

It would appear, however, that students become conditioned to "learn" for the type of test expected. In this study, across all subgroups, high numbers of lines drawn accurately in the concept maps and large increases in the number of lines drawn from pretest to posttest showed no correlation with test scores. Students with high, middle and low test scores had the highest or lowest numbers of lines and/or the most increase in number of lines drawn accurately after reading the hypertext. Since there is no pattern to these standings, both preferred learning style and flexibility of cognition could be involved.

The higher success rate in connecting lines than in stating relationships could be a result of the former being a nonverbal task; to draw lines, it could be sufficient for the student to intuit a relationship. This possibility could explain why the students who drew the most lines in each of the honors subgroups on the pretest did not increase the number of lines in the posttest. Stating the relationship between two concepts requires 1) specific knowledge about the concepts and 2) articulation, even if to oneself, of the way in which they are related.

A second consideration is that honors students in particular might use strategies other than knowledge of history to compose their knowledge structures; for example, linguistic cues in the names of the concepts. Honors students, who are likely to be more verbal than regular students, might also have responded more sensitively to the words used in the given relationship statements from which they were to choose.

Third, since the same amount of time for reading and testing was afforded each classroom of students, those in the regular class subgroups might not have been able to process the information as quickly as the students in the honors subgroups. Consequently, they might have chosen hastily or indiscriminately just to get through the agenda. Also, motivation to complete an academic task successfully is often higher among honors students than among regular high school students. Filling in the relationships was the last task to be accomplished on the last day the students were in the computer laboratory, and motivation might have worn thin at that point.

Reading from the computer hypertext was an independent learning procedure. Some students normally rely on verbal information from the teacher to select those details that will most likely be on the class test. Having to gain detailed information from one's own silent reading of a random access hypertext might have interfered with retention of the larger ideas or with the student's learning style. Perhaps more than employed instructional strategies such as a curriculum map or an advance organizer, it is the student's learning style that influences achievement in learning from a hypertext. Some students were able to "connect" concepts with some logical reasoning on the pretest before reading about the topic and then did worse on the posttest after the reading.

The students were told they would have a test after reading the hypertext, but they were not told they would be repeating the concept mapping. Since their class tests require knowledge of detail, it would be possible that some students tried to read for detail but did not do it well. They might have been successful in "connecting" general pieces into a larger picture on the pretest, however, by relying on general knowledge. Perhaps reading for detail interferes with the task of composing knowledge structures; those who were grade-conscious possibly read for detail in order to do well on the achievement test and missed the larger relationships.

After the two different types of cognitive assessment were administered, students' attitudes toward using the hypertext were elicited. The general feelings among the students were that they were comfortable using a computer in class, would not use it as a main source of information in place of a textbook, and did not enjoy using it to learn social studies information. Their oral expressions of apprehension about the achievement test they would be taking on the material they read independently from the screen might be a clue to their lack of enjoyment in using the computer to learn about the social studies topic used in this study. One student' expression seemed particularly relevant: "I like it better when you just tell us what we need to know." !

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Toward Combining Programmed Instruction and Constructivism for Tutorial Design

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The suggestion that programmed instruction and Constructivism might be combined in the creation of tutorial software seems contradictory when one considers the differences between the two theories. Programmed instruction, which is based on operant conditioning, is reductionist focuses on external control and reinforcement. On the other hand, constructivist approaches view learning a process in which individual students construct or build their own internal interpretations of external events. These assumptions about learning are very different and indicate the two theories are incompatible. However, if one considers the type of knowledge the learner is expected to acquire, then there is room to consider what each theory can contribute.

Programmed Instruction

Tutorial and drill and practice, two forms of CAI (computer assisted instruction), are the best known applications of programmed instruction (Jonassen, 1990). Traditional CAI is organized, according to behavioral theory, as a series of stimulus-response patterns. The learner is exposed to a stimulus and responds. The learner then experiences a consequence which can be an aid in the shaping of the learner's behavior. The information or task to be learned is broken down into small segments that are mastered one at a time. Each segment is added to previously learned segments until the final behavior is achieved by the learner. This is the basis for programmed instruction.

Skinner (1968) described programmed instruction as having clearly defined content which is presented in small increments. As small units of the content are presented a the learner is presented with a question that must be answered (stimulus). The student answers (response) and is told whether the answer is correct (consequence). This sequence is similar to the six steps found in the design of CAI by Case and Bereiter (1984). This general model was used to develop much of the current tutorial software, even though it is incorrectly implemented a great deal of the time (Poppen & Poppen, 1988).

Constructivism

Constructivist theorists contend that the learner is an active participant and builds his or her knowledge based on individual experiences. According to Piaget (1954) the individual constructs meaning from experiences by accommodation or assimilation. The individual understands new experiences by relating them to prior experience. If the current experience doesn't make sense in relation to prior experiences, disequilibrium occurs. Disequilibrium requires the individual to readjust existing mental schema or create new schema in order to create meaning or understanding of the event that caused the disequilibrium. When an individual has a flawed understanding of a concept, Brooks (1990) recommends providing opportunities for disequilibrium to occur. Brooks states that these opportunities are more effective for clarifying understanding than alternatives such as trying to verbally explain the flaw in the individual's understanding.

Duffy and Jonassen (1991) suggest that for meaningful learning to occur individuals must work with realistic problems in realistic contexts. Since problems usually have many aspects, multiple viewpoints should be explored by students in order for them to build networks of related ideas. While there are suggestions that the curriculum needs to be changed in order to accommodate this type of learning (Papert, 1993; Griest, 1993), the present reality present for most teachers and students is the need to meet state and district curriculum guide demands.

Computer tools are one of the easiest means of incorporating constructivist theory into educational computer use. Learners are then working in "authentic" situations which should increase their comprehension of how to use ideas and information (Duffy & Jonassen, 1991). Jonassen (1990) suggests that such things as hypertext, databases, and expert systems can be used as *mindtools* by individuals. These tools help individuals construct their knowledge in authentic ways. While many educators are using these forms in the classroom in place of other forms of software, they cannot fulfill all of the curriculum needs in the amount of instructional time available.

Constructivism and Tutorial Software Design

Non-linear multimedia and/or hypertext design can be used in the creation of constructivist tutorials. Students can choose not only the pace at which they move through the material but also the paths they will follow through it. Their understanding of the material would be constructed through exploration. Matthew and Williams (1994) created and implemented this type of hypertext tutorial for university students. The tutorial content used semantic maps to focus on three overall topics: early writing, invented spelling, and composition. These were further divided into sub-topics. Learners could then move through the topics using buttons that would take the learner to any topic. In this manner a student could move through the tutorial in both linear and non-linear ways. Certainly, tutorials using non-linear design may be educationally effective in helping students learn. However, students often move more slowly through the material and in K-12 education that may take time away from other important areas of learning. This may not be what educators actually desire because achievement is not always improved as a result (Ross and Morrison, 1989). When actually using software in the K-12 classroom, we need to consider the instructional time used. If one method takes more time and delivers approximately equal achievement, it is not as efficient. Therefore, while we may want to use constructivist methods, we may find it more efficient to combine it with other methods. There is both the demand for factual learning and problem solving in most current curriculum documents. Blending the use of programmed instruction and constructivism may enable tutorial software to address both areas within the curriculum better than strategies based on one or the other theoretical base could alone.

Combining Programmed Instruction and Constructivism

It may seem to be a contradiction to combine programmed instruction with constructivism to create tutorial software. However, it can be seen that programmed instruction is good at helping students learn a set of terms and very structured information, while constructivist approaches help students deal with real problems in ways that enable them to solve problems. There are other views of constructivism and behavioral theory that indicate that each may be useful in different ways during the process of learning.

One idea is that while the parts of the cognitive structure are unique to the individual, the *syntax or structure* of that information is not. This indicates that a knowledge base can be represented independent of any individual (Merrill, 1991).

Winn's (1991) view suggests that "basic knowledge of well-structured domains" (p. 39) still needs to be taught because the individual needs knowledge from which to begin construction. Merrill (1991) suggests that we can "represent knowledge in a knowledge base" (p.47) which can contribute to a somewhat shared reality. Jonassen (1991) believes constructivist learning may be most appropriate for "advanced knowledge acquisition" (p.31) and that introductory knowledge is best approached in other ways.

According to Von Glaserfeld (1989) there is a difference between training for skill acquisition and helping the learner build understanding. This is because the learner maps objective reality in a way that fits previous experiences. Therefore, it can be argued that for basic information in a content area, some instruction of basic concepts, terms, and skills needs to take place.

Teachers must follow curriculum guides that provide goals and objectives for what students are expected to learn. Some of the objectives involve the learning of facts, basic skills, and concepts. A way other than constructivism may be more productive in helping students learn this type of material. Programmed instruction may be the correct model to use to provide learning experiences which would aid the learner. This would not be sufficient instruction though because more and more curriculum guides are also addressing the need to have learners be problem solvers. Some theorists suggest that one of the strengths of constructivi m is that it situates problem solving and prescribes generative learning environment in which the lea ner deals with real problems in real or simulated situation (Cognition and Technology Group, 1991). How can this in ormation be used to inform tutorial software design? Seve al aspects of constructivism can be incorporated into a utorial software package. Some of these aspects are: (1)-activating student's prior experiences and knowledge; ( ) having the learner create knowledge structures as they ove through the material (such as graphic organizers); (3) iving the learner a choice of example types and problems; a d (4) providing real world problems for structured domains (here one correct ans er or a finite number of known answers are expected).

Questions can be used to activate the student's prior knowledge. Key words and phrases could be used to check the student's responses and provide specific feedback. However, even in programs that have many response-feedback matches, there is still the possibility that an individual would answer in an unexpected way. Unexpected answers could be written to a file which could be reviewed and appropriate responses written to be added to the program.

Learners could benefit from consciously building the mental frameworks they will use to retain the new information. *Frames* could be inserted which require learners to organize the information they are learning. For example, as students work their way through a tutorial in which they are learning about reinforcement schedules, they could be asked to create a graphic organizer or an outline. This graphic organizer or outline would not be checked by the program, but could be called up by the student if the student wanted to refer to it or make changes to it as understanding changed. To create this organizer for reinforcement schedules, students could be asked to give features of each type of reinforcement and place them in whatever order seemed appropriate to them. As each type of reinforcement is introduced each student could be presented with their organizer and could make changes. Periodically, throughout the tutorial students would be asked to revise their graphic organizer. The major purpose of this would be to have the student actively organize the new information into a structure. This structure could then be analyzed by both the learner and the teacher to get a clearer view of how the student is thinking.

As we know, motivation to learn something can be enhanced if the topic is of interest to the students. Not all students required to learn a given topic are interested in it. One way to activate their interest and prior knowledge is to incorporate those interests when something new is being learned. This can be done during the development of the software by considering the general intersts of the target population. If possible, surveys could be conducted to get an idea of the most common areas of interest to that student group. Then several areas of interest could be incorporated into the software.

The last area for inclusion would be real-world problems that fit within the content being taught. When using tutorial software, the problems would need to have only one or a limited number of possible "correct" answers as too much open-endedness would be difficult to monitor in order to give the student appropriate feedback. These types of problems would be appropriate in structured knowledge domains. However, one could include simulations which would allow more open-ended responses for less structured domains. Since simulations are difficult to design and program, this option would require considerably more effort than tutorials.

While basic knowledge delivery would be in a programmed instruction form, adding some aspects of constructivist theory may aid student's in activating prior knowledge and help them become aware of their own construction of knowledge. Allowing students to choose examples and problems and providing real-world problems may also contribute to a more efficient learning environment.

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Cooperative Learning Ventures Using Microsoft Products and Other Selected Programs

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Research over the past 20 years have confirmed the positive cognitive and social benefits of cooperative learning. Cooperative learning, simply stated, is a teaching strategy or practice of dividing a class into small groups which work together on a common project.

Advantages of cooperative learning

The advantages of cooperative learning are many. These are:

it improves academic performance among high and low achievement students
it develops social skills
it improves students' self-esteem
it improves students' understanding and retention of materials
it improves attendance
it improves students' attitudes about school, subject areas, and teachers
it improves students' attitudes toward mainstreamed students and race relations
it provides opportunities for negotiation
it enhances students' desire to learn
it encourages good communication skills and higher-level thinking abilities
it accommodates a wide variety of learning styles

Drawbacks of cooperative learning

Some drawbacks of cooperative learning need to be considered. These are:

the increased noise level often leads to distraction
lack of social skills sometimes creates situations leading to conflicting opinions and failure to get down to the task at hand
the possibility of having aggressive students do the work for the entire group
the possibility of having students of lower abilities dominated by students of higher abilities
the possibility that the group as a whole may take too long to complete the assigned lesson

Basic components of cooperative learning

Using computers in cooperative learning has more or less similar advantages such as those mentioned earlier in this paper, i. e., improvement of academic achievement, promotion of social skills, and improvement of students' self-esteem (Krendle & Lieberman, (1988); Webb (1984); Johnson and Johnson (1985). Cooperative learning itself consists of some basic elements which are: positive goal interdependence, face-to-face interaction, individual accountability, social skills, monitoring, and group processing.

Any cooperative learning lesson or project must contain the above components (Rottier & Ogan, 1991). Teachers can organize almost any lesson plan to include cooperative learning components. A sample computer-based cooperative learning lesson plan is found in Appendix A.

Other computer-based cooperative learning lesson plans using Microsoft products such as *Encarta, All About Dinosaurs, Fine Artist, Creative Writer, Musical Instrumentts* and others are to be distributed during the conference session.

Various group selection techniques

Choosing the size and makeup of a group is very important. The key to successful cooperative learning is carefully structured teams. Research indicates that groups of two or three are most effective, with two being the optimum number (Krendl & Lieberman, 1988).

There are various random group selection techniques for cooperative learning. This works well especially when ability levels are nonessential to the task (Rhoades and McCabe, 1992). One popular group selection method developed by Dr. Stanley Schainker from San Francisco is the birthday line. Have students arrange themselves according to the month and date of their birthdays. Those born in January are first in line and those with the last birthday in December are the last in line. Once the line is formed, count off to form groups. Another method is the alphabet line. Have students arrange themselves in alphabetical order according to first name or surname. Those whose names start with A's are first in line and those with names starting with Z's are the last in line. Once the line is formed, count off to form groups. Other variations for the line arrangement include height and shoe size.

A third method is using the name tags. This gives the teacher the opportunity to form either heterogeneous or homogeneous groups carefully without making it obvious to the students. Select an identifying number, letter, or name for each group and determine the workspace for each group. Make a sign, logo, or symbol to identify each group and place it at the appropriate work location for each group. Make name tags for each student and decide on the composition of each group. After the teacher has decided on the composition of each group, write the group's identifying sign, symbol, or logo on the student members' name tags. Give each student his name tag and tell each one of them to assemble in the workspace with the symbol, sign, or logo that matches the one on his name tag.

Students' assigned roles and the teacher's roles

Various roles can be assigned each group member. This works well with more than two in a group. Some suggested roles to choose from are: recorder, summarizer, checker, time keeper, reader, materials monitor, encourager, and observer.

The classroom teacher has many responsibilities in cooperative learning situations. The teacher is a stimulator, encourager, mediator, coach and facilitator. The teacher must structure the cooperative classroom, mediate each group's work, present problems or tasks, question, monitor both individuals and teams, and act as a consultant.

There is no best teaching strategy to achieve maximum learner success, just as there is no best medium. The decision of incorporating cooperative learning in an instructional lesson should be made carefully basing on the lesson content and objectives; thoughtful planning should be done.

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Appendix A

Sample Computer-based Cooperative Learning Lesson Plan

GRADE LEVEL: 8th - 9th
SUBJECT AREA: Math—Algebra

LESSON/PROJECT TITLE: *Alge-Blaster Plus* (by Davidson & Associates)

A. GENERAL OBJECTIVES:

1. Students will practice and show mastery of Integers

B. MAKING DECISIONS:

1. **Group size**: two students per group
2. **Procedure for assignment to groups:** The teacher will assign one high-ability and one mid-ability student or one mid-ability and one low-ability student in each group.
3. **Classroom arrangements needed:** The students will be asked to go to the computer lab so two students can use one computer.
4. **Resources needed**: Computers, program disks, LCD with overhead projector, paper and pencil
5. **Types of group cohesion:**
    - a. Goal: interact cooperatively to reach goal of a good grade
    - b. Reward: individual and group grades given

c. Task/role: Have high-ability student work with student of lower ability on computer. First, the high-ability student works on the computer and the other student writes down the equations and answers. For the next level, they will switch places so both will learn in the process.

C. PREPARING THE LESSON/PROJECT

1. **Academic**
   - a. **Specific objectives:**
     - (1) Students identify and demonstrate problem-solving
     - (2) Students identify and define integers
     - (3) Students write down the problem and solutions as completed on the computer
   - b. **Prerequisite knowledge and skills:**
     - (1) Knowledge of some computer skills
     - (2) Knowledge of positive and negative Integers

2. **Social**
   - a. **Creating group cohesion:**
     - (1) Positive role cohesion will be promoted by specific role the group will need
     - (2) All students must sign work papers when they have finished to indicate all agree with the answers
     - (3) Group completing the lesson/project with the highest score in the minimum amount of time will receive extra points
     - (4) The teacher will call randomly on one member to explain the group's answer
   - b. **Role assignments:**
     - (1) General agreement between partners

3. **Procedures for creating individual accountability:**
   - a. Students will have a quiz on different Integer skills at the end of the lesson
   - b. Students will put initials on all work papers turned in to indicate their joint agreement

4. **Specific social skills to be reviewed:**
   - a. Stay in workspace
   - b. Work quietly
   - c. Follow classroom rules
   - d. Get in and out of groups in an orderly manner

5. **Social skills that need to be taught:**
   - a. Accept constructive criticism
   - b. Do not allow put-downs
   - c. Include everyone in the group
   - d. Encourage group members
   - e. Use materials appropriately

D. MONTORING PROCEDURES:

The teacher will observe by walking around the classroom and keep tally marks of positive social behaviors observed, using a teacher-produced observation chart.

E. PROCESSING PROCEDURES TO BE USED:

1. Group discussion
2. Self-evaluation

F. EVALUATION:

1. **Individual performance:** Students will take a quiz
2. **Group performance:** Each group will be graded on two different aspects: a grade on answers received on work papers turned in and a grade on performance of roles
3. **Social skills performance:** Each student will be judged for his performance of social skills
4. **Procedure for determing composite grade for lesson/project:**
   - a. Four grades wil be given:
     - (1) On the individual work paper turned in
     - (2) On the quiz given at the end of the lesson
     - (3) On performance of group as a whole
     - (4) The teacher's own observations of the students' behavior within the group, using a teacher-produced observation chart

TECHNOLOGY DIFFUSION

Section Editors:
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Diffusion is often defined as an intermediary step between innovation and common access and usage. The diffusion of technology within educational settings is complicated by a number of societal, pedagogical, financial, and human factors, as well by the fast-paced nature of continuing technology development. The papers in this section are concerned with this process of diffusion—how to encourage widespread effective use of educational technologies in K-12 and post-secondary institutions.

The section opens with Dolly's examination of the history of the promise and practice of technology in schools. He argues that if colleges of education are to hold a leadership role in the design and delivery of quality instruction, they must make the transition beyond the surface use of technology to a highly integrated use for their own classroom instruction and must develop a strong agenda of research and development on the use and integration of technology in the classroom.

The section continues with three papers which focus on modeling improved instruction in higher education through integration of technological resources. Topp, Mortenson, and Grandgenett describe efforts at the University of Nebraska to support education faculty integrate technology into their teaching through the acquisition of equipment, provision of training, and establishment of expectations for technology usage. Papalewis introduces a newly established telecommunications link between the California State University and the University of California, the CSU-UC Interactive Video Teleconferencing Link. She discusses the potential for and current use of this system which enhances educational programming by enabling faculty, students, and administrators on multiple campuses within each system to have "face-to-face" live video and voice interactions without the necessity of interstate travel.

Atkinson describes how the closing of a military base is being capitalized upon to create a new California State University campus with a high speed computer network that connects museums, institutions of research and higher education, libraries, and schools for the purpose of promoting the exchange of information on marine science and environmental issues.

The next group of papers bridge the worlds of universities and public schools by considering the preparation of K-12 educators. Kazlauskas and Casey's papers argue that teacher educators must expand their technology instruction for preservice and inservice teachers from the typical model of learning how to use the equipment for administrative work and curriculum integration. Kazlauskas is particularly concerned with keeping teachers informed of new sources and technologies for information access, while Casey calls for the inclusion of information on innovation diffusion and purposeful change in school settings.

Schuttloffel and Bennett, Tipton, and Bennett focus on the important role school principals play in their school's adoption of information technologies. Schuttloffel describes the development of a handbook designed to help principals understand the process of technology implementation, the necessity for teacher inservice, and the potential for technology to serve as a catalyst for school reform. Bennet,

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Tipton, and Bennet examine changes in school administrators' attitudes toward their leadership role and use of instructional technology in classrooms as a result of participation in a 14-week staff development program designed to help them become more supportive, well-versed technological leaders in their schools.

Studies of technology diffusion in K-12 schools are considered in the following three papers. Stuhlmann describes a multiple-case study of teachers participating in a telecommunications project initiative. Using the Concerns-Based Adoption Model, she assessed the participants use of telecommunications with their students, their concerns about using these technologies, and changes needed to increase the effectiveness of training and encourage further participation in the project.

Anderson, too, uses case study methodology to examine change. She identifies factors which have limited and contributed to the continuation of the adoption of computers in a small, rural school district.

Marcinkiewicz, Moore, and Baumberger describe a study of the integration of MIDI piano keyboards into regular music instruction within elementary schools. They report that students exposed to MIDI keyboards exhibited more positive attitudes toward music and school.

Twining's discussion of difficulties with interpreting the literature dealing with the implementation of computers in schools helps focus on the broad issues we must all consider. He cautions against generalizing from past research and calls for researchers to specifically define terms and variables pertaining to their studies of computer use in schools. Such changes are necessary if future research is to help us turn a vision of learning enhanced by computer use into a reality.

The final paper, by Thompson, describes the integration of one particular type of IT, telecommunications, in a teacher education program. The *final* final paper in this section, by Gillan and Dubois on cooperative learning, was added by the general editors just as the Annual was shipped to the printer. It was placed here because fewer changes in the table of contents and author index were required compared to placing it in the hypmermedia section.

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Technology and Change in Colleges of Education

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As we struggle to improve public education we have turned to technology as a potential solution. A cycle repeats itself in education. As new technologies are developed, we make predictions about their future impact on schools and students. After a few years we assess what has really happened and often find the technology has not had the impact projected. This cycle has occurred so often that we shouldn't be surprised when educators fail to embrace the newest technologies as solutions to their problems. Educators want more than hype, they want evidence of success before they change.

Dolly (1985) addressed the impact information technology could have on teacher education. Ten years ago there were technologies being developed that appeared to have potential for bringing about positive change in public education. Although schools have started to use some of these new technologies the impact has not been dramatic.

In the book entitled, *Instructional Technology*, edited by Anglin (1991), authors are careful to make the point that technology is a tool and to be effective it needs to be based on solid learning theory and used appropriately in the delivery of quality instruction. In many instances both of these critical characteristics are missing. People in the technology industry sell materials that push the use of equipment, portraying the equipment as a way to improve the quality of instruction and learning. The sophistication of the technology used means little if the instruction being delivered is poorly developed and provides little value to the learner. Sophisticated technology can be used to teach important concepts or junk. It is important to keep in mind that technology is a tool and by itself has very little power to improve the quality of education unless it facilitates the delivery of high quality materials that are appropriately designed to make the best possible use of the technology available. Very often we see a high degree of interest in new technology because of its novelty and this novelty has tremendous stimulus value in capturing the attention and interest of both students and teachers. However, once the novelty wears off one must critically assess what positive impact the use and introduction of technology has had on learning. Far too often we fail to see this kind of critical analysis in the literature (Jacobson, 1994).

The use of digital CD-ROM appears to offer something that technology has lacked in the past. Unfortunately, we are once again at the point where we have a new technology that offers great promise, but the promise is based on the assumption that someone (company, individual, etc.) will develop quality material needed to provide the kind of instructional experience that makes the investment in equipment, time and effort worth the price. The people in the field of technology are rushing to embrace the CD-ROM technology as the new answer to all our instructional problems. Many of them forget that the primary function of CD-ROM is greater storage capacity. According to Schwier (1991) "Remember that interactive instructional technology is only a potential solution if you first have an instructional problem" (p. 195). The question is who will develop the quality instruction? We are now able to bring the technology down in price to the level where schools can design their own materials. This may be the step that has been missing in the past and may be the catalyst for greater use and integration of technology into public education. The ability of schools to design materials that are locally based, representing their students and their needs, makes the potential of the CD-ROM more exciting than previous instructional and technological innovations.

As Dolly (1990) noted, schools have already made massive purchases of technology without clearly defining the goals and objectives of the instruction to be delivered by new technology. Instead we appear to have a situation where teachers are being asked to modify the curriculum to fit the available technology instead of identifying the technology which may help teach the curriculum. Pogrow (1983), stated this creates a situation where technology will drive public education and not necessarily become a tool of educators.

Reiser and Salsberry (1991), argue that for instructional technology to have a positive impact in public education, we will need a radical restructuring and redesign of schools. Educators have been arguing very strongly that schools need to be restructured for the sake of good instructional practice. This is independent of the infusion of technology. Although their argument has some validity, we have yet to see extensive research on the use, application, and demonstrated efficacy of technology for school learning. Until we have a research base demonstrating that the introduction of technology will improve the quality of education, it will be very hard to justify a restructuring of public education. According to Park and Hannafin (1993), there is a dearth of research literature supporting the use, application and effectiveness of technology. We appear to have a field that does not take high quality research, either quantitative or qualitative, seriously. Reiser and Salsberry (1991), argue that important improvements will not come about through piece meal changes. Although such a statement is true, if one can't show positive change even in small scale studies, one is hard pressed to convince a school system or state to radically change its system of schooling on the promise of instructional effectiveness.

Restructuring should be based on the need to improve overall instruction, independent of technology. To argue that we should restructure schools to facilitate the use of new technology seems far fetched given our history of introducing new technology with great promises and being unable to deliver long term on those promises. Reiser and Salsberry (1991) have indicated that there is a significant need to improve the quality of software for schools. This is the critical point. Unless we have quality instruction and high quality software that has been developed with a strong empirical base, the use of technology is not going to improve public education.

Colleges of education have the opportunity to take a leadership role in developing quality instructional materials to use with technology. They need to be seen as centers of innovation in the design and delivery of high quality instruction across content areas. Colleges of education are logical places to locate a research and development effort to improve schooling and learning. If colleges of education fail to take a leadership role it can only be hoped that some other organization will.

In many colleges and schools of education technology still remains something of an aloof, poorly defined area of study disconnected from traditional coursework and experience. In some universities technology is taught by faculty who hold appointments in a department or program called Information Technology or Educational Technology and courses are taught about the use and application of various technologies. The problem with this approach is its high cost and questionable value. When students are required to take technology based courses, the resources necessary to insure that all students complete the course can be expensive. You end up with a labor intensive high cost program to introduce limited numbers of students to the application of technology. Although this introduces students to the use of technology it fails to insure that they will use the technology to teach once they are in the classroom. If we are serious about introducing our teacher education students to the use and application of technology, then it must be seen as something useful and effective for conveying appropriate content and knowledge to students in the classroom. College students need to see a complete range of applications and they need to be required to use technology in a variety of contexts.

To get our faculty to introduce the use of technology in their classes, we must make the introduction as easy as possible. This means strong support on the use and application of new technology in the classroom. Faculty need to be shown how to use it appropriately and need to be given support on the use and integration of technology so they themselves can demonstrate it appropriately for future teachers.

We have the data, teachers teach the way they were taught (Goodlad, 1994). If we hope to influence public education, the influence must occur within teacher preparation programs, not on an inservice basis once people are out in the public schools. If we had several classes in a teacher education program requiring students to use and integrate technology in their assignments, we would move the introduction of technology along at a much more rapid pace than simply providing students independent isolated courses on the use and application of technology that is divorced from their methods courses and practicum experiences. According to Knupfer and Zollman (1994), "If teachers are to use technology effectively in their teaching, then they need meaningful experiences using the technologies"(p. 332).

Dolly (1986-87), points out that colleges and universities have been making considerable investments in the acquisition of new technology, but are not providing the technical support that is necessary to keep faculty up-to-date on what's available and how to appropriately use it. We need to insure that faculty will be the first people provided information and instruction in the use and the application of new technology. Universities must make an ongoing commitment to have adequate funding and equipment to support a greater use and integration of technology in colleges of education.

As noted by Means and Olson (1994), even though there has been a significant introduction and availability of technology for teachers, most teachers still close their classroom doors and go about teaching the way they were taught. With this model as the predominate model in public education, there is little information about how technology is being used by teachers or even if they use it at all. We never get to determine if they use it effectively. Based on this, perhaps some restructuring of education must take place before technology can be effectively used in the classroom.

One of the concerns often overlooked is that new technologies will force teachers to improve their instructional and interpersonal skills so they can relate more directly to individual students as instruction becomes more individualized. If teachers are going to become managers of a complex array of instruction, they will have to become more sophisticated in the use and application of instructional models and understand the course content to a degree not formerly required of most teachers. This means that those teachers who are marginal before the introduction of technology will be of less value to a school after technology is introduced. The marginal teacher who might have survived by lecturing to a class of 30, will have a great deal of difficulty individualizing instruction at multiple levels of conceptual complexity using microcomputers to integrate multimedia technology. The technology will accentuate more accurately differences in skills and abilities across students and teachers.

The danger in selling technology as a solution to instructional problems is the notion that we have found a way to help those students who are not performing within the current education environment. There is no evidence to indicate that this is true. Those who have the necessary background and knowledge base to expand their learning will do so. Those who lack the basics will still encounter difficulty in dealing with more complex learning situations. Bright students will do even better and learn more information when its presented in a sequenced, appropriate, reinforcing format. Park and Hannafin (1993), indicate the difficulty ineffective learners have in creating and using cognitive guides in learning new information. When we have diverse groups of learners, the better students will gain at significantly greater levels than students who lack prior instruction or the ability to organize appropriate information in a way that makes it usable in the future.

In many schools there is a great deal of commentary about the fact that we have x number of computers or that we have so many computer laboratories to support our students. There is no assessment of the quality of the experience being provided to students. One thing we have learned in higher education is the need to provide direct support to faculty if you hope to have faculty use computers in the delivery of the curriculum. To have faculty use computers at all, we must make them as easy to use as possible. Without technical support and without help when things don't work faculty will abandon the use of technology, particularly those who have no deep understanding of its use or applications. A key component in any successful program is the provision of technical support to those using and applying the technology. In the past we have bought equipment and we have provided computer programs, but in many institutions we have failed to adequately support the equipment with the technical expertise to keep it up-to-date and to help those who are trying to use it to improve their own instruction. In order to get support for the integration of technology into the classroom there must be faculty involvement and support. Faculty that are not involved in this integration will see it as an add on and a burden and not something of value to them personally.

Hannafin and Hannafin (1991), point out that research carried out in the use and application of new technology tends to be published in isolation from previous research and in isolation from a theoretical or research framework. This isolation of research from any central core or ongoing research agenda creates a hodgepodge of independent research studies that lack coherence and a tie to a central theory on the use, application, or value of technology. They comment about the non-research orientation of many people in the area of technology and believe this has had a negative impact on developing a core of research that would support the appropriate use and implementation of new technology.

According to Park and Hannafin (1993), "Typically guidelines for interactive multimedia design are based not upon empirical evidence, but on the intuitive beliefs of designers" (p. 63). They go on to say after summarizing a significant number of research articles carried out on interactive multimedia that most of these articles emphasize strategies that have intuitive rather than empirical validity. They indicate that the futurists believe that the new technologies will alter the role of teachers and students. Teachers will assume the roles of facilitator and coach while our students become more independent and responsible for their own learning. This model assumes that teachers have a thorough grasp and understanding of the depth, complexity and use of instructional programs that would be developed for multimedia. It also assumes they can they can explain, enhance, and enrich the presentations made via interactive multimedia technology. These are characteristics of good teachers, whether they use multimedia or not. Not every teacher has this capacity. Although the tools for instruction and the tools to support instruction are improving, it is still the teacher who is the key to insuring adequate, accurate, and meaningful reinforcement of learning in her/his interactions with students. As Park and Hannafin (1993) point out, our new technology has enabled us to accumulate incredible amounts of data and information providing an overwhelming array of factual material for students. The key is how do we assess this material and organize it so that what you use in the classroom is meaningful and related to desirable learning outcomes. This is an area of research that should be pursued by colleges of education.

In the edited text, *Instructional Technology* by Anglin (1991), the reader can quickly see some of the problems faced by people working in the area of technology. Although the text is referenced extensively, there is very little referencing to hard data demonstrating the use and effectiveness of technology across a variety instructional situations. It is this lack of a research base noted by other authors that forces us to step back and admit that we don't have the data, and we don't have the evidence to show that we can make a significant difference in schools. Until we develop within the profession a strong, aggressive, research program to investigate the use, implementation and outcomes of various technologies across different learners and under different conditions, we will have to settle for a regurgitation of other people's opinions much like this article rather than relying on real data with real people to make our predictions and summations.

After looking at much of the literature, the reader comes away with a feeling of here we go again. Five years from now we will be saying the same thing about digital based CD-ROM multimedia technology that we have said about the introduction of television, microcomputers and other forms of technology that have not had the desirable impact we predicted five or ten years ago.

Unless colleges of education exercise some leadership in demonstrating to schools how we can best use new technology and use it to effectively address instructional problems, the new technology will be a passing fad. Many people in education and particularly those enamored of new technologies fail to deal with some of the very basic issues. Does it improve learning? Is this a faster, more effective way to provide quality instruction? Is it cheaper? Is it easier? The bottom line, does it work as claimed, i.e., improve the quality of learning for the population intended?

What have we seen over the last ten years? We've seen computers come to be common everywhere in the university and in some instances everywhere within the public school system. But what have we actually gained from this use and introduction of a relatively sophisticated piece of technology? We have developed strong word processing programs and often require students to use them for their courses. We have also found that the computer is a useful place to store information and analyze large sets of data. Beyond that everyone appears to be using the microcomputer for E-mail with colleagues. Only in the business community and military do we see the widespread use of integrated instruction and technology. They have more clearly designed their learning objectives and instructional materials. In colleges of education we are still arguing over our goals for instruction. Very few people in colleges of education have made the transition beyond the surface use of the technology to a highly integrated use for the improvement of their own classroom instruction. Unless we provide faculty with one on one instruction on the use and application of these tools, we will continue to use the computer at less than 25% of its potential capacity.

If we want a leadership role in the design and delivery of quality instruction, we must do more than just talk about it. Colleges of education must pursue a strong agenda of research and development on the use and integration of technology in the classroom.

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Goal: Technology-Using Teachers; Key: Technology-Using Education Faculty

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Preparing teachers to use computer-related technology in their classrooms is an exciting challenge for the educational community, especially for teacher preparation institutions. Teacher education is often criticized for the lack of technology preparation education majors are receiving. In a 1990 national survey, 81% of the student teachers surveyed rated their undergraduate preparation in technology use as inadequate (Fratianni, Decker, & Korver-Baum, 1990) and in a 1992 study over 67% of the Iowa teachers surveyed evaluated their preparation in college to use computer-related technology as inadequate (Topp, 1993).

To address the issue of educational technology, two national organizations, the International Society for Technology in Education (ISTE), and the National Council for Accreditation of Teacher Education (NCATE), have jointly written goals for the educational computing and technology preparation of students in teacher education programs. These goals include demonstrating knowledge about computers and the effective use of computers in classrooms (Wetzel, 1992). These goals are not only focused on individual computer proficiencies, but also, on the strategies and skills needed to incorporate computer-related technologies into learning and teaching.

Many teacher education institutions are implementing steps to achieve the ISTE/NCATE goals, as well as their own goals for preparing future and present teachers in the use of education technology. This changing process is important to the future of education and its institutions.

Three Key Elements: Equipment, Training, and Expectations

Three elements seem to be key in the increased use of technology in teacher education institutions. First, the *equipment* must be available for both faculty and student use (Johnson & Harlow, 1993; Novak & Berger, 1991). A computer on the faculty member's desk is one of the first steps in using the computer-related technology in teaching. When the computer becomes a necessary tool for the teacher, then the use in the classroom is the next logical step (Johnson & Harlow, 1993). In addition, if computers are to be used for class purposes, a facility that will accommodate such class activity is necessary (Gunn, 1992).

The second element involved in faculty empowerment with technology involves faculty *training*. Because of the perceived stature of the higher education faculty member, it is often assumed that they need little training in the use of something new, in this case, computers. This is usually untrue, and the training and subsequent support and coaching are vital if effective use of technology in higher education is going to take place (Wetzel, 1992).

The *expectation* that faculty will actively include technology in their teaching and research is the third element related to increased technology use. Faculty members need to feel that effective use of technology is expected for all appropriate courses and situations. They need to feel they are being supported, as well as encouraged to use and model teaching techniques that include efficient uses of technology (Nelson, Andri, & Keefe, 1991; Novak

& Berger, 1991). Faculty members must also believe that their environment is supportive of the "risk taking" necessary for trying new teaching/learning techniques involving technology. Some universities have included the integration of technology into classroom teaching as a part of the faculty growth formula, while others have encouraged technology integration through equipment allocations (Gunn, 1992). The perception that using technology in teaching is expected, and worth the risk, is an important factor in the continued increase of educational technology use in teacher preparation programs.

The University of Nebraska at Omaha College of Education Model for Technology Integration

The faculty of the College of Education at the University of Nebraska at Omaha, under the leadership of the dean, has developed a model for technology integration into teacher education. Educational technology was identified as a major goal by the college eight years ago. This goal was divided into teaching about educational technology, teaching with educational technology, integrating educational technology into the design and delivery of curricula, and engaging in research regarding the use and effects of educational technology in the teaching/learning process.

The college initially developed a plan addressing the three areas presented in the previous section of this paper: equipment, training, and expectations. This plan has evolved over the past several years, and will continue to evolve, as the faculty progresses and educational technology and its use continues to change.

Equipment

During the past seven years, the College of Education has made a concerted effort to provide faculty and support staff with desktop microcomputers. Three general guidelines were established to provide direction and rationale for these computer purchases. First, the support staff of the college would use a PC platform for administrative functions. This provided uniformity across the college as well as easy electronic transfer of data. Second, faculty were allowed to choose either a PC environment or a Macintosh environment for their personal desktop microcomputer. Third, high-end users would receive newer models, while trickling down their computers to low-end users. These guidelines provided general direction as the college moved ahead in providing basic microcomputer technology to each faculty and staff member in the college.

In order to help in the teaching process, the college has designed, built, and equipped three mobile multimedia teaching stations called Smart Carts. Each of these Smart Carts is equipped with a microcomputer (2 have PC's and 1 has a Macintosh), an overhead projector and LCD panel, a video projector, a VCR, a laserdisc player, and a CD-ROM player. These carts can be moved from classroom to classroom throughout the two main buildings used by faculty of the College of Education.

The University, following the lead of the College of Education, has recently begun a project designed to develop and install "high-tech" classrooms throughout the campus. These classrooms contain state-of-the-art multimedia equipment to support integration of educational technology into the design and delivery of curricula. Currently, there is a "high-tech" classroom in one of the two buildings occupied by the College of Education, and two more "high-tech" classrooms are scheduled to be installed in College of Education buildings in 1995.

Early in the technology planning process, the college installed ethernet connections in all faculty offices, instructional areas, microcomputer laboratories, research laboratories, and support staff workstations in preparation for a local area network (LAN). Once connectivity was established for this LAN, a college file server was purchased and installed.

It was necessary for the college to employ a LAN administrator to service the growing educational technology needs of the college. Initially, a graduate student in computer science was employed to manage the college LAN on a part-time basis. The demands on the LAN administrator soon exceeded the part-time appointment, and a full-time position was developed for an educational technology coordinator for the college. This position, in addition to administering the LAN, provides support services to all faculty and staff within the college, as well as equipment maintenance and installation. The educational technology coordinator also assists in educational technology research and provides one-on-one technical assistance to all faculty and staff in the use of the college LAN and its resident software programs.

Recognizing that computers for student use was important to the educational program, the college has written proposals in which grant funds have been used to establish student microcomputer laboratories. Several sources of outside funding have been obtained over the last seven years to purchase equipment for several student labs. The most recent addition to the college's student facilities is a 30-station PowerMac Electronic Data Connectivity Microcomputer Laboratory, funded in part by U S WEST Communications.

As the laboratories became outdated, it has become necessary to replace older computers (e.g., Apple IIes, XTs, 286's) with newer equipment. This has been accomplished with college and grant funds. It is important for the college to provide students in the teacher education program with basic hands-on experiences with PC, Apple, and Macintosh platforms. These experiences provide students with the skills necessary to use the basic microcomputer technology found in most K-12 schools. Beyond the basic instruction on the various platforms, students receive more in-depth instruction using the Apple and Macintosh microcomputers, as these are the prevalent platforms found in local school districts.

Training

The faculty development efforts of the college were designed around three levels: awareness, experience, and integration. In the awareness level, faculty were provided with several opportunities to merely be exposed to the vast uses of educational technology in the classroom. These sessions focused on getting faculty aware of and excited about the potential of technology use in the teaching and learning process. Also, it further provided faculty with a basic knowledge of several software programs. For the experience level, faculty were provided with opportunities to experience some of the technology uses in a supportive and comfortable "hands-on" environment, where knowledgeable individuals were available for assistance. For the integration level, faculty were provided with learning opportunities which focused on sharing how certain technologies might be used in instruction. This phase also permitted faculty to share with each other some of their integration ideas and plans. Each of these training activities addressed improving instruction, expanding research, and increasing scholarship using the resources available through educational technology. This training of faculty and staff at each level, has been addressed in two primary ways, summer intercession training and brown bag presentations.

Summer Intercession Training. The college provided faculty the opportunity to engage in "hands-on" training sessions during summer intercessions. These training sessions have typically been for one to three weeks. Initially, faculty were all provided with basic instruction regarding the use of a networked microcomputer laboratory along with its software. During the sessions, each faculty member developed projects that utilized the technology and were relevant to their respective areas of expertise. Eventually, the intercession summer training sessions became more individualized, focusing upon specific needs and interests of participating faculty. Upwards of twenty faculty per year have participated during the five years this program has been in operation. In addition, the training format has been altered to provide large group instruction as well as one-on-one instruction and technical assistance.

The overall training during these intercession activities was designed to meet the needs of faculty members at their own level of expertise. The expertise of participating faculty ranged from those with very little knowledge of technology, and no experience with its use in teaching, to those with some knowledge of technology, who do not currently incorporate it into their teaching, to those currently using technology to some degree in their classroom instruction. All sessions encouraged faculty to address their own specific needs and interests, and to help be a resource to each other following the session.

The following topics have been addressed over the past five years:

- productivity tools for curriculum integration (MS Works, Storyboard, Linkway, HyperCard, Persuasion, and Harvard Graphics);
- resource applications (instructional aspects of the Internet that support the teaching/learning process, and applications of Mosaic for effective navigation through the Internet);
- experiential applications of integrated hardware and software resources available in high tech classrooms or with mobile multimedia carts;
- integration of computer managed educational technology and media in the classroom; and
- restructuring teaching and learning applications using educational technology in a high tech environment.

Brown Bag Presentations. In addition to the intercession training, the college also provided training throughout the academic year in a series of "brown bag" lunch hour presentations. These were offered by the college's Educational Technology Coordinator and several technology-using faculty members. These presentations primarily focused upon the use and integration of software programs resident on the college's file server, which is connected to every faculty member's office and all instructional classrooms in the buildings used by the College of Education via a local area network (LAN). Topics for these workshops included a variety of software applications such as MS Works, Paradox for Windows, SPSS, E-Mail, Gopher, Trumpet News, FTP, and Mosaic, as well as other high interest topics such as the use of multimedia and the Internet. These focused sessions, usually one hour in duration, were followed by coaching and encouragement from the instructors, as faculty and staff members implemented the newly learned skills.

Expectations of Technology Use

Expectations and encouragement are vital to the infusion of technology into the educational process. In the College of Education at UNO, these expectations have come from the dean and associate dean, the departmental chairs, and the general faculty.

The dean's office has consistently provided high expectations and much encouragement for educational technology use by faculty. This has been accomplished in four ways: a) identifying educational technology as one of the two major goals of the college, b) expenditure of college funds to purchase educational technology, c) support of faculty engaged in advancing the use of education technology, and d) strengthening educational technology through grants and other outside funding sources.

Individual departments within the college have also encouraged integration of technology into their respective areas. Technology use and infusion are frequent topics of departmental meetings. Also, proficiency in using and integrating technology is a factor in the selection process, as new professors are hired.

The college also has established an Educational Technology Task Force, comprised of faculty, administrators, and support staff, from all departments. This group has been instrumental in providing operational direction to the educational technology vision provided by the dean of the college. This task force, operating in concert with information provided by a similar group of educational technology personnel representing the seven metropolitan Omaha school districts, has provided the college with input that has resulted in:

- A College of Education mission statement for educational technology.
- Goals and objectives for the college in the area of educational technology.
- Educational technology competencies expected of all preservice and inservice teachers.

- Research studies reflecting the type and amount of educational technology utilized by the faculty of the college.
- A coordinated plan for the purchase of all educational technology equipment for the college.
- A formal advisory group to the dean of the college for feedback and future directions related to technology integration.

Results

The use and integration of technology has greatly increased in the College of Education over the past few years. All full-time faculty members use e-mail as a part of their academic routine, as well as a significant number of faculty now regularly use presentation software, such as Persuasion, to deliver class presentations, use resources on the Internet, or take their classes to one of the college's computer laboratories (such as to demonstrate the use of electronic mail or accessing the campus wide library and information system). Also, many professors are including educational technology as a part of their research agendas.

As the emphasis on technology has increased, many uses of technology have involved individual applications for specific courses. Such integration has included a wide variety of computer uses, ranging from multivariate computer analysis in graduate research courses, to the simple use of word-processing in undergraduate basic education courses. All departments have made a concentrated effort to keep up with the college goals, and to integrate technology into their academic activities.

More advanced and focused technology courses, instructed by the Teacher Education Department, are also available for college-wide enrollment. These courses include an undergraduate instructional systems course, and a sequence of five graduate education courses, which all focus on educational technology use in the classroom.

Yet in addition to the more formal integration of technology into the college departments, such as in the courses offered, an informal "computer culture" is also developing among the faculty, both within and between departments. This "computer culture" is often most apparent by the genuine interest in educational technology shown by most everyone on the faculty, as evidenced by the routinely high enrollment in the optional intercession training sessions (often as much 1/3 of the faculty at any one time). This evolving "computer culture" has also worked to help bring individual college departments more together, by involving them in a shared interest and common training activity. This shared interest has even facilitated several joint projects between departments, such as a technology-rich mathematics and literacy clinic for learning disabled elementary students.

Summary

The model set forth by this paper focuses on three important elements to reach the goal of effective integration of technology into the College of Education curriculum. These three elements, equipment, training, and expectations, must all be addressed by the teacher preparation institution. Up to date equipment must be available to all faculty, staff, and students. Faculty and staff must be given training, as well as support and coaching, that addresses all levels of expertise. And, of course, there must be a consistent expectation that educational technology is important and must be used and integrated by all educators.

The overall mission of the college has been to improve learning for all students. Including educational technology in the preparation of future and present teachers is an important factor in achieving this goal. In order to effectively infuse technology, the faculty must become aware of technology's potential, and they must be active and confident users of technology. The College of Education at the University of Nebraska at Omaha has seen significant progress toward achieving the goal of technology integration, through the use of the plan described in this paper.

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Collaboration between the California State University and the University of California for More Extensive Teacher Taining Programs

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Of the recent technological developments affecting higher education in California, perhaps few will be as significant to the academic welfare of the state's students as the interconnection of the sophisticated communications networks of the California State University (CSU) and the University of California (UC). This link, which is expected to be fully operational in Fall 1994, will enable the state's two university systems to work collectively to better serve the needs of California schoolchildren, primarily through more effective teacher training programs.

Traditionally, the California State University has provided the academic foundation and training for about 70-percent of the state's teachers. In contrast, the University of California has focused more on theoretical issues related to teacher education. A basic intention of the CSU-UC Interactive Video Teleconferencing Link is to facilitate a stronger marriage between the theory and practice of teaching and to, in turn, provide current and future K-12 educators with unparalleled knowledge and skills.

The CSU-UC Interactive Video Teleconferencing Link will comprise, in part, CSUNet, the major telecommunications network of the California State University. CSUNet currently links all 22 CSU campuses and some off-campus centers. Among its provisions are Internet access, advanced FAX services, two-way compressed video (Codec), international connections to Sprint Meeting Channels, and to locally, regional, national, and world-wide networks such as BARNET, CERFnet, NSTnet, CARL and UCNetwork. In addition, CSUNet makes possible the complete range of data, voice, video, and image communications across the 22-campus system. A similar comprehensive system is in place at the University of California.

The potential of the CSU-UC Interactive Video Teleconferencing Link to enhance the quality of teacher education and training is apparent with the California State University, Fresno/University of California Joint Doctoral Program in Educational Leadership (JDPEL), the state's only publicly supported inter-segmental and multi-campus joint doctoral program. Indeed, it is largely because of the JDPEL's distance-learning needs that this crucial technological partnership was initially established.

Specifically designed to enhance the skills and talents of educational leaders residing in California's Central San Joaquin Valley, the JDPEL draws upon the scholarly expertise of 38 interdisciplinary professors from CSU Fresno and five UC campuses, including Davis, Los Angeles, Riverside, Santa Barbara, and Santa Cruz. It is served by two co-directors: one from the California State University, and one from the University of California.

Although the multi-campus nature of the program naturally lends itself to the use of interactive video teleconferencing, for three years JDPEL faculty and students were forced to rely on less sophisticated modes of communication, such as telephone, fax, and electronic mail. Moreover, because all classes are held in Fresno, UC faculty and staff were required to do considerable travel to the Central San Joaquin Valley.

This past August, JDPEL professors from UC campuses were able to begin delivering courses to Fresno from their university sites. In addition, video teleconferencing technology is used to facilitate academic advising, administrative consultation, and informal interaction pursuant to the education-leadership doctoral degree, and to foster additional opportunities for CSU-UC faculty collaboration and student research. Since all dissertation committees have faculty from at least two campuses, all meetings are done via Codec.

The JDPEL, while certainly the first inter-segmental program to benefit from the CSU-UC Interactive Video Teleconferencing Link, is not the last. There are ambitious plans to extend the reach of this modern technology to all disciplines served by the agrarian out-reach model that merges theory and best practice. For example, veterinary research and practices delivered via Codec link the campuses of UC Davis, and CSU Fresno and San Luis Obispo.

One of the most noteworthy of these plans involves MSTECC (Mathematics and Science Teacher Education Collaborative for California), a National Science Foundation-supported project designed, in part, to improve teacher education in the fields of mathematics and science. MSTECC will be based in the Monterey Bay Region and will rely heavily on the resources of the universities in that area, including UC Santa Cruz and CSU Monterey Bay. Other partners in this broad-based collaborative effort include Monterey Bay area public schools, libraries, museums, scientific research organizations, and business/industry partners who have combined forces to develop a networking infrastructure across the region.

Like the JDPEL, MSTECC will be served by both a California State University co-director and a University of California co-director. Also like the JDPEL, the inter-segmental MSTECC project naturally lends itself to the use of video teleconferencing. At present, though—much like the JDPEL during its first few years of operation—interactions related to MSTECC are conducted by more archaic means. This is expected to change in the very near future.

The significance of the linkage networks between the University of California and the California State University is threefold. First, with the global and complex needs of the state's population, with the reality of a minority-majority populace and an exploding pre-K-12 growth rate, it becomes imperative for the state's two public higher education institutions to not duplicate efforts nor stand separate in initiatives that bridge theory building and best practices. As ordained under the Master Plan of Higher Education, the California State University meets the needs of the workforce of the State of California, and the University of California meets the research needs of the nation and world. For the state to continue to foster this dichotomy is not recognizing the tremendous needs of the state. Technology will serve as a viable tool for inter-segmental collaboratives, both instructional and administrative.

Second, the linking in professional disciplines of the best of minds from across all institutions in the state strengthens our abilities to change and aid in the redefining of the workforce. For example, technology is beginning to serve the school to career transitions by linking the community colleges, CSU, and UC to pre-K-12 efforts.

Last, the need to be more responsive to our K-12 colleagues, both in pre-service and on-going professional development will be aided by the linkage between CSU and UC. Working with interdisciplinary professors researching teaching, leadership, and human resource issues, in institutions from across the state, puts at the fingertips of students a richer breadth of experts and a more comprehensive array of best practices.

As academies of the future serve the workforce of California and specifically the teaching profession, individual physical locations will have less meaning. Our ability to link, collaborate, integrate, and mentor one another is enhanced through the technology link.

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Regional Collaboration on School Reform: Overview of the Monterey Bay Regional Computer Network

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The closing of the military base at Fort Ord has spawned a major collaborative effort towards the redevelopment of the entire region. The nerve center for this effort is a new high speed computer network that connects institutes of higher education, research, and museums with the public schools and libraries. The focus of this new network is on promoting information in marine science and environmental issues. K-12 teachers and students, higher education, researchers, and the general public all stand to benefit. Improved data connections should foster school reform efforts as well as extend the capabilities of higher education, researchers, and local businesses.

Background

As "necessity is the mother of invention," the economic crisis caused by Fort Ord's military base closure is *birthing* an unprecedented collaborative effort between the research and educational institutions surrounding Monterey Bay. The goal of this collaboration is to establish the region as an international center for education and research in the marine and environmental sciences. The former Fort Ord site is already being transformed into a new California State University (CSU) campus with additional plans for a University of California (UC) sponsored research and development park.

The high technology and advanced digital communications that form the region's central nervous system is bringing life to this redevelopment effort. New high speed data lines are currently being installed in a cooperative venture with Pacific Bell through their CalREN Foundation. Additional funding and equipment support are being provided by the National Science Foundation, Sun Microsystems, and Apple Computer. Much like the San Francisco Bay area network, the Monterey Bay area network is a collaboration between institutes of higher education, research, and museums with the public schools, community groups and libraries. The main planning partners for the Monterey Bay Regional Network are the UC at Santa Cruz (UCSC) Education and Computer Engineering Boards, CSU at Monterey Bay (CSUMB), Cabrillo College (CC), the Monterey Bay Aquarium (MBA), Monterey Bay Aquarium Research Institute (MBARI), the Naval Postgraduate School (NPS), the Monterey Peninsula Unified School District (MPUSD), and the Santa Cruz County Office of Education (SCOE).

Network Design

The computer network design consists of a three tiered approach (please see Figure 1). The first or top tier (backbone) is high speed Asynchronous Transfer Mode (ATM) over fiber optic lines which connect the major institutes of higher education and main research partners consisting of UCSC, UC Extension, the Tech Museum, CSUMB, MBA, MBARI, and NPS. These lines will enable viable full frame interactive video applications between the nodes. The second tier (ISDN and frame relay) connects in the training and support centers consisting of UCSC, Cabrillo College, and county/district offices of education. The third tier (ISDN and frame relay) represents the main consumers sites (along with some secondary information provider sites) consisting of K-12 schools, libraries, and community organizations.

Target Audiences and Main User Groups

The regional network is being designed to meet the needs of several target audiences. K-12 students and teachers are the main target group for improving the region's public education and furthering school reform. Efforts are already underway to equip local schools and train teachers in the use of computer networks in teaching and instruction. Computers and networks have been found to be an especially effective tool in teaching about the environment and science (Novelli, 1994; Kramer, 1991). To make the network especially effective for the K-12 users, pedagogy will be based on curiosity driven learning (Arnone, 1991; Curiosity, 1992; Menis, 1984), humor and creativity (Moran, 1994; Reynolds, 1989; Thousand, Villa, & Nevin, 1994), in a hands-on approach. After establishing the pedagogical uses of the net in this region, the net will be expanded to California's Central Valley area then nationwide.

In addition to K-12 educational users, the general public and regional community groups are other target groups of network users. To expand access by the general public, information will be presented bilingually in both English and Spanish. With the eventual involvement of UCSC's language faculty and even possibly the Defense Language Institute, providing information in a smorgasbord of languages becomes possible. Furthermore, unique needs of various community organization, such as Senior Net, are being considered in the net design.

Finally, the needs of more traditional network users of higher education and scientific research are important considerations. For higher education, the network provides communications to the outside world as well as new ways of delivering instruction. For scientists, the network provides new ways of collecting data, sharing and manipulating data sets, as well as the publication and dissemination of results.

Network Segments

Economic Development. The closing of Fort Ord and the subsequent loss of jobs in the region has underscored the need for economic and commercial uses of the net. The net will help foster the region's local businesses as well as provide new economic opportunities. A first application may be as a advertising medium for local businesses. For example, users will be able check the current film schedules. In addition to the standard reviews, video film clips and trailers can be downloaded upon demand, as well as interactive reviews contributed by the users themselves. Restaurants can post current menus, receive orders, and get paid for their services over the network. In fact, many forms of merchandise can be advertised and sold over the network, including clothing, books, motel rooms, and wet suits. In fact, the possibility of fostering commercial interests for the long term funding of the network and to subsidize non-profit and educational uses is being considered.

Besides aiding businesses, providing current job listings over the net is yet another method of stimulating the local economy. By providing job information in a searchable database form, job seekers can tailor their searches more to their own needs. Also, the exchange of resumes and even initial interviews can take place over the net.

One facet of the local economy that deserves special mention is tourism. The Monterey Bay area is blessed by abundant natural resources and has recently been declared a National Marine Sanctuary. Consequently, this area is often a destination for travelers from all over the United States and the world. The network can provide valuable information for tourists and travelers for sites to visit as well as special events. Such sites would include the Monterey Bay Aquarium, Long Marine Lab Visitor's Center, and the Santa Cruz Surf Museum. Other activities encompassing *eco-tourism* would also be available, such as, kayaking, whale watching, tours of Ana Nuevo, and boating excursions. Information on the many parks and hiking trails would also be available.

Community and government. The community and government segments of the net would be responsive to the informational needs of both community groups and local governments. Community groups, such as Senior Net, Easter Seals, and the Cabrillo Stroke Center would be able to post announcements of special events, programs and services offered as well as communicate with participating members. Similarly, local governments (e.g., city and county) would be able to post important legislation, meeting notices, and even conduct discussion forums centered around local issues.

K-12 Education. One of the main segments of the net is dedicated to K-12 education to help improve and reform our regional public schools. The K-12 segment of the net will be used to provide raw material and distribute completed curriculum products. These materials will run the full gambit from plain images and data to completed curriculum packages and projects. Students and teachers alike will fill the roles of information consumers and providers. For example, raw data and images from the MBARI deep sea rover will be available over the net for teachers to develop curriculum and give class demonstrations, which then can be published on a server for other teachers to use. The students themselves then can use the same MBARI information for individual or group multimedia projects which they can, in turn, share with the rest of the class, or even post on the school server (Novelli, 1994). This style of teaching does represent a dramatic role shift from the "sage on the stage" to the "guide on the side". Considerable training for teachers will be needed to accomplish this role shift, not only for teachers learning the new technologies and computerized teaching techniques (MacLachlan, 1989), but also for how to function in a coach/facilitator role.

Beyond educational materials development and dissemination, the net will facilitate communication between the K-12 community and the scientific research community. Collaborative scientific experiments and direct communications with scientists and researchers themselves become

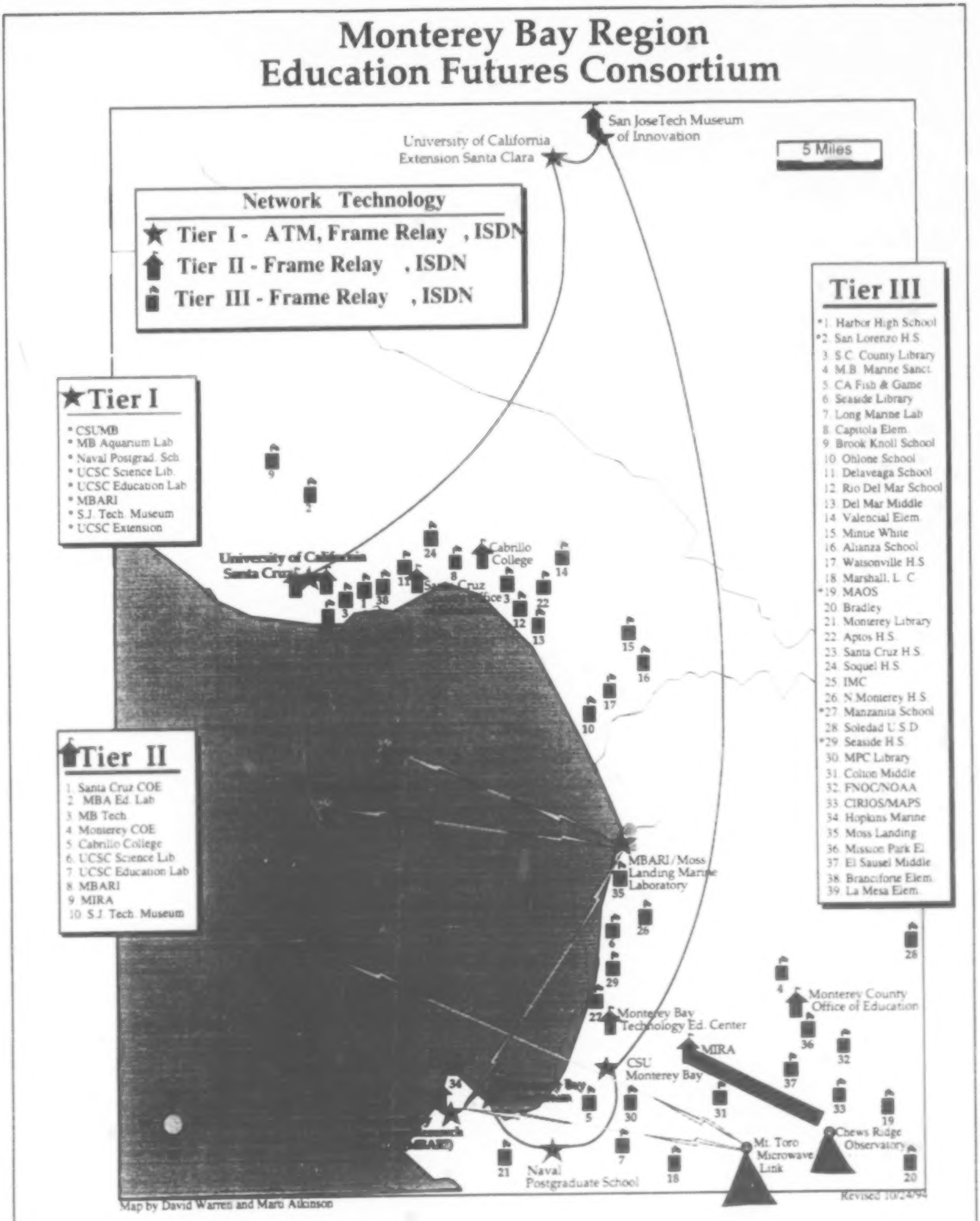
Monterey Bay Region
Education Futures Consortium
Network Technology
Tier I - ATM, Frame Relay, ISDN
Tier II - Frame Relay, ISDN
Tier III - Frame Relay, ISDN
5 Miles
University of California Extension Santa Clara
San Jose Tech Museum of Innovation
Tier I
CSUMB
MB Aquarium Lab
Naval Postgrad. Sch.
UCSC Science Lib.
UCSC Education Lab
MBARI
S.J. Tech. Museum
UCSC Extension
Tier II
1. Santa Cruz COE
2. MBA Ed. Lab
3. MB Tech.
4. Monterey COE
5. Cabrillo College
6. UCSC Science Lib.
7. UCSC Education Lab
8. MBARI
9. MIRA
10. S.J. Tech. Museum
Tier III
*1. Harbor High School
*2. San Lorenzo H.S.
3. S.C. County Library
4. M.B. Marine Sanct.
5. CA Fish & Game
6. Seaside Library
7. Long Marine Lab
8. Capitola Elem.
9. Brook Knoll School
10. Ohlone School
11. Delaveaga School
12. Rio Del Mar School
13. Del Mar Middle
14. Valencial Elem.
15. Minnie White
16. Alianza School
17. Watsonville H.S.
18. Marshall, L. C.
*19. MAOS
20. Bradley
21. Monterey Library
22. Aptos H.S.
23. Santa Cruz H.S.
24. Soquel H.S.
25. IMC
26. N.Monterey H.S.
*27. Manzanita School
28. Soledad U.S.D.
*29. Seaside H.S.
30. MPC Library
31. Colton Middle
32. FNOC/NOAA
33. CIRIOS/MAPS
34. Hopkins Marine
35. Moss Landing
36. Mission Park El.
37. El Sausel Middle
38. Branciforte Elem.
39. La Mesa Elem.
University of California Santa Cruz
Cabrillo College
Santa Cruz Office
MBARI/Moss Landing Marine Laboratory
Monterey County Office of Education
Monterey Bay Technology Ed. Center
MIRA
CSU Monterey Bay
Naval Postgraduate School
Mt. Toro Microwave Link
Chews Ridge Observatory
Map by David Warren and Marc Atkinson
Revised 10/24/94

Figure 1. Monterey Bay Region Education Futures Consortium.

possible. Computers have been found to be especially effective for environmental education and in particular for studying phenomena that extend beyond the students' immediate area. For example, students studying the effects of pollution on fish populations in a nearby river or stream would be able to collaborate with other students making similar studies in other parts of the country. These students could then compare their data with other studies of famous rivers, e.g. the Amazon, throughout the world in a collaborative fashion. Beyond student/teacher collaborations, the net will make communications with actual scientists and researchers working in these disciplines easier and more practical. However, care must be given to maximize participating scientists' time. Researchers are notoriously busy individuals and while they may want to contribute to K-12 education, they simply don't have the time to answer repeated basic questions. Consequently, a moderator is needed for K-12/scientist communications. A graduate student or retired researcher could fill this role by fielding questions, formulating a Frequently Asked Questions (FAQ) database, which in turn be used as a design principle for presenting online learning materials which naturally follow the learners' curiosity (O'Donnell, 1993).

Higher Education. High speed computer networks may completely change the delivery of higher education. In fact, the speed at which higher ed institutions are embracing this medium is truly amazing. On a basic level, the net will serve as a new medium for distributing publications. College bulletins, application forms, course catalogs, class registrations, syllabi, lecture notes, and even student course evaluations can all be published electronically online reducing the need for paper distribution and thereby reducing costs.

The most revolutionary applications for higher ed may be found in distance education. The delivery of distance learning and/or courses freed from the time/space continuum opens educational opportunities to a much wider audience. Classes can be recorded, stored on a server and called back at a convenient time to the learner on a dial-in distributed fashion. On the regional level, UC systemwide has recognized the need for campuses to cooperate in offering courses which are expensive or impractical to duplicate from campus to campus. For example, a course offering in Swahili can be taught from one campus with students enrollments coming from campuses throughout the system in a distance learning format. Cooperative classes between the CSU/UC systems also become both feasible and possible. Already efforts are underway to combine instructional efforts for teacher education on technology. University Extension classes and special seminars could also be offered in such a format. Plans are already underway to offer computer engineering classes taught at the UCSC campus into Silicon Valley and vice versa.

Research and Scientific Community. The new high speed net affords the research and scientific communities with new options in sharing data and manipulating databases as well as disseminating findings. Already, the relatively long and expensive cycles for the paper publication of scientific findings is becoming impractical in some quickly moving fields. For the environmental scientists, online real-time data collection over the network will enable new ways of collecting data that may not have previously been so easily obtainable. The ability to place large archives of data sets online to share with colleagues is already becoming a viable use (Taylor, 1993). The NPS has 17 years of ocean temperature and current data correlated with weather patterns. This data has been distilled down into a short computer animation illustrating the formation and dissipation of the El Nino current, which strongly influences our weather patterns. Video email and desktop video conferencing with shared windows for collaborative work projects also promise to completely revolutionize the way scientists and researchers communicate and work together.

Summary

The Monterey Bay Region stands to reap multiple benefits from the installation of high speed data lines which enable advanced forms of digital communications. Economic development for local businesses and jobs is expected. K-12 school reform can be fostered as well as teachers and students themselves becoming effective information consumers and providers. Higher education can improve communications both to the outside world and intercampus, resulting in possible costs savings and being able to reach a wider audience of learners. Finally, the scientific and research communities will be afforded with new tools for data collection, analysis, and results dissemination as well as new communication tools for collaborative work.

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86.1

Innovation, Information, and Teacher Education

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Innovation in its broadest sense refers to change based on advances in science and technology, to new products and processes, and to changes in management, attitudes, practices, and relationships. It has been a common theme found for a long time in the literature of many fields, such as management (Drucker, 1985; Rogers, 1983) and education (Carlson, 1965; Guba, 1968; Kemp, 1994). It is, and will remain, to be of importance to any organization that wishes to survive in a world where rapid and continual change is the norm.

The definition of information for this paper is very broad and refers to messages containing data, theories, ideas, opinions, and so on; and delivered through a multiplicity of approaches, such as communication devices, conference and meeting presentations, personal discussions, books, journals, databases, pictures, and multimedia. That there is a connection between innovation and information is obvious. New ways of doing things, new demands, and new opportunities in general need to be encoded in messages of some kind and communicated. A review of the models of the process of innovation identify the essential role of information. These studies have repeatedly observed that greater awareness of information and the ability to manage it are elements of prosperous and competitive organizations (Brown & Karagogozglu, 1989; Carter & Williams, 1957; Porter, 1990; Roberts & Frohman, 1978; Sweeney, 1989).

Maguire, Kazlauskas, and Weir (1994) conducted an analysis of the literature on innovation and information, drawing from fields such as human communications, economics, sociology of knowledge, engineering, science and technology, organization theory, technology transfer, and research management. They observed that a strong link exists between innovation and information; that for an innovative organization to be successful, good information (among many other factors) is a requirement. It emerges then that an information policy is a requirement of an overall organizational strategy, and that innovative information services, including those technology-based, are contributors to the innovation process in an organization.

Using the results of their analysis of the literature, various propositions were adduced relating to innovation and information. These propositions are categorized as relating to: innovation as a phenomenon; organizations as information processing systems; the effects of technological change; and information user behavior. Although these propositions relate to organizations in general, they appear particularly of interest to schools in this era of technological change and the demand for school innovation. These principles, thus, are discussed in relation to schools. Some additional principles appropriate for the design of information services in schools are presented, along with some comments on the integration of the content into a course on instructional uses of computers.

Innovation as a Phenomenon

Innovation is centrally a matter of organization, rather than of technology. Firstly, technology based educational systems, no matter how effective, require acceptance by the organization. Indeed, for an organization to take up an idea, its members must be persuaded that it is useful and useable. And secondly, a new technology is not an innovation until it is integrated into the practice of the organization. Merely placing computers into the classroom is not an innovation. Teachers must be trained to use the computers; computers must be integrated into the curriculum; and administration must support and foster the use of computers in the classroom.

Managerial style is a more important determinant of the effects of technological innovations on an organization than the technology employed. Any change is inherently unsettling and will exacerbate the inefficiencies and ineffectiveness in organizations. It is at that point that management style will determine the effects of this technology on the organization. Various positive techniques, such as early involvment of all constituents in decision-making can assist in the positive implementation of a technology.

In considering a specific example, e-mail can provide for a more open school environment and open more channels of communication among school constituents. Indeed it can create the open information flows that are essential to innovation. But conversely, this same technology can tighten the controls and have the opposite effect. In another example, the implementation of a computer-based school administrative system can be imposed on the old system without reviewing the operation. Merely layering the new technology-based system on the old, without a reconsideration of the ways things are done, is poor management style.

Progress is Not Linear

The early thought was that the process from invention to innovation to implementation was a linear process. But today there is an appreciation for the complexities in this process and in the diffusion and lack of diffusion of apparently useful knowledge. The 'goodness' of technology-based instructional systems and documented research evidence does not necessarily mean that the innovation will be accepted and applied. In particular, ideas that require paradigm change and those which require major intellectual effort by an unconvinced person are harder to sell.

The more complex the system into which an innovation has to move, the more resistance it will meet. New ways of doing things and new ideas have to move through modern complex societies. And, indeed, the modern school system is a complex entity. Those who seek to promote innovation in schools have to reckon seriously with the investment that has been made into existing systems and into the training of teachers for these existing systems.

Opinions differ on whether innovation is more likely to be achieved in small or large organizations. It is useful to note that there is evidence that size is a determinant of what strategy is used to innovate rather than a determinant of whether innovation will take place. The move towards smaller school organizational/management entities (site-based management) may facilitate the use of certain innovation strategies but does not necessarily mean that the entity will be more innovative than the larger parent organization.

Organizations as Information Processing Systems

There are many different modes of information gathering, analysis, and distribution in organizations and therefore many different information services. In the broad sense every division or department acts as an information service to others. But it seems reasonable that those entities with the broadest responsibilities, such as the library-media center, telecommunications and computer services, should seek opportunities to share their expertise as well as to diffuse information services provided by other departments within the organization. The move towards integrated information systems combining resources of the library-media center, internal management information, such as classroom scheduling and student information, and external information resources, such as the multiplicity of sources on the Internet, made accessible through a "scholarly workstation," is a move towards the integration of these diverse information services. As a corollary to this proposition, it should be noted that organizations depend on both formal and informal sources and channels of information and a mix of internal and external information. A computer-based information system with internal and external text-based information may provide only a part (although a major part) of the information needed.

The more senior the executive, the more preoccupied the executive will be with news. News is defined as the first appearance of some intimation about an aspect of the future which is of crucial significance to the organization. This news is less likely to be in "print" form and, thus, senior management, such as principals of large schools and school superintendents, tend to concentrate on live information sources, that is, discussions with people face-to-face or on the telephone. These senior executives are less likely to use information in libraries or in records of past activities of the organization, such as those contained in reports and correspondence. But easy and transparent access to information sources in "print" form is essential to those individuals, such as administrative assistants, who provide the live information on which management base their decisions.

Innovative organizations are learning organizations in which training is very important. Learning is an activity which is neither over before one enters the workplace nor preserved for management level positions. Inservice training is an essential element in the acceptance and use of any innovation in schools. This is even more important to consider in technological innovations, such as computer-assisted-instruction, where the training aspect may be as significant a cost as the hardware or software. And this training is on-going as the technology itself undergoes change.

Effects of Technological Change

Instability caused by technological change calls for constant review of buy, make, and lease decisions in organizations. There are various factors which come into play when considering both the instructional and administrative aspects of computerization in schools. These include the decreasing costs of computing, increasing storage capabilities, and the trend towards down-sizing, that is towards network-based microcomputers versus mainframes and minicomputers. These developments as well as other trends that are found in other types of organizations, such as in contracting for services outside, keep changing the cost-effective mix of existing systems within schools.

Inter-operability of systems, dis-intermediation, globalization, and convergence are all simultaneously causes and effects of adoptions of information technology. Inter-operability makes information systems appear transparent to the user; while dis-intermediation reduces the steps between user and producer. The resulting effect is to bring more information directly to the user, whether the student, teacher or administrator. The net result is information overload, such as important messages being overlooked and anxiety over the amount of information that exists. Increasingly, there is the need for information filters which can separate the valueless from the valuable in the deluge of data in information-rich environments. The Internet is a classic example of the globalization of information. It exacerbates the information flow, but cannot be ignored.

Information-user Behavior

Accessibility is the most important determinant of choice of an information source. This factor has been repeatedly shown to be the major factor in the choice of an information source, more than any other factor, including the value of the information. Fortunately, new technologies are making access more readable, such as microform based collections of periodical articles and newspapers found in school library-media centers, full-text sources available online, and multimedia applications, such as CD-ROM encyclopedias. There is also a psychological aspect to this proposition in the perceived intellectual level required to access the information source. Complex computer information systems generate their own level of inaccessibility, and thus may be dismissed in favor of more accessible, simpler, systems.

People prefer to be in control. The issue of intellectual inaccessibility is an issue of control whereby individuals are reluctant to use systems that are difficult. Library studies have shown that students frequently give-up without obtaining results and without seeking help. This issue is exacerbated by the increasing availability of more complex computerized information resources to library-media users. The development of more user-cordial interfaces (and standardization) is in order.

There is widespread ignorance about information sources and information services. In line with the previous proposition, the development of more user friendly systems is not the only answer. In general, information services are underused and are only used by a fraction of the population for whom they are potentially useful. The importance of information literacy, and its counterpart technology literacy, are essential elements in K-12 education, and indeed in lifelong learning.

Some Added Principles for Design of Information Services in Schools

Using these propositions, some principles for the design and management of innovative information services in schools can be formulated. Information services need to be flexible and multifaceted. Today a school can employ a variety of digital and multimedia technologies for enhancing the approaches to information services. These technologies typically allow flexibility of access through a variety of options, including text-based systems, nested menu design such as Gopher, and hypertext applications such as Mosaic. But in addition to the technology aspect, this principle can apply to the organization. Multifaceting in information service responsibilities include the expanded role of the school library media specialist as the information specialist, teacher, and the instructional design consultant.

No information service has a monopoly. With the multiplicity of sources and delivery methods, collaboration is essential among various 'information-rich' constituents, namely the library media center and computing and telecommunications services. The overall goal is to promote the creation of, and access to, information resources in a networked environment.

Intermediary roles at the microlevel need to be translated into transparent systems. Technology can facilitate the empowerment of users in the use of information at the individual level, while information service personnel should become more involved in the information literacy education function.

Information services must be people-based rather than collection-based. Traditional library collections have been limited to the extent that they can provide access only to a small proportion of the information they contain and oftentimes serve only a small percentage of the people who could use the content. Technology-based systems can rectify this situation and provide a more user-oriented systems.

Role of information 'gatekeeper" will remain important. Not all information can be encoded into a machine nor understood even when in machine form. Political and personal information is not always amenable to digitization.

Integration of Concepts into Course

Traditionally a course in instructional use of computers in schools consists of establishing a certain level of computer literacy and of integrating the computer into the curriculum. An added element in our focus is on basic administrative computing applications. These indeed are major components of our course. But in order to provide prospective teachers with a broader perspective, there is the integration of innovation and information content, namely that discussed in this paper, into the course in the form of lecture, readings, and final examination question.

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Presenting Teachers With A Model for Technological Innovation

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In the 1970s many thought that computers were going to revolutionize American education, but by the 1980s, the promise faded and people began to ask, "What Revolution?" (Tucker, 1985). In 1994 most classrooms remain essentially unchanged by computing; the dominant technology used to support instruction in the majority of American classrooms is still the chalkboard. Why is this so? Why have the anticipated benefits of computer technology failed to penetrate pedagogical practice in our schools? This paper posits that the missing link between the promise of technology and classroom reality is lack of leadership for innovation. I examine school leadership and discuss a model of innovation in an attempt to explain why educators have failed to adopt computer technology. Finally, I propose a model of school leadership that offers an opportunity to support innovation involving technology.

Educational Computing

Computing was first introduced to the pre-college classroom in the mid 1970s in the form of computer aided instruction (CAI). The initiative came, for the most part, from university-centered research projects. Schools interested in innovation were sought out by university researchers, and school boards or school principals volunteered classrooms to be part of studies of the efficacy of computer-aided instruction. In fact, the actual number of classrooms affected was small and there was little substantive curriculum change as a result of this early computer use (Taylor, 1980). Moreover, early computer programs were modeled directly on traditional instructional practices and materials. The innovation had little to do with reforming curriculum and less to do with improving teaching. In fact, early users of computing were exploring whether machines could teach — more as a substitute for or adjunct to teachers than as an enhancement to teaching practice. This is not to say that early developers were trying to replace teachers with machines (although this was certainly the fear of many teachers), but there was little vision that teachers could use technology as a regular part of their repertoire. The vision of the electronic chalkboard and the computer as an instructional tool had not yet dawned.

With the development of the desktop computer, computing began a gradual move into the school environment. The computer moved from its early experimental uses in CAI and became instead the main focus of the instruction. As so often occurred in the past, the medium became the message (McLuhan, 1964). It was claimed that teaching children to be computer literate would prepare them for a future that was certain to be dominated by technology.

During the 1980s, a more enlightened view of computers and other technologies began to emerge. No longer viewed as an end in itself, computing began to be seen by many educators as a tool to enhance both teaching and learning. By the end of the 1980s, the computer began to be used as an instructional tool to present material in ways not possible by traditional means. The number of schools using computing was growing, but computer-using educators were still the exception rather than the rule. Curricular uses of computing remained remarkable rather than commonplace. Schools were then and still are far behind just about every other institution in their use of technology.

The Problem

Computing has totally infiltrated the business world and has changed the way museums and libraries deliver information to the public. It is rapidly becoming an accepted and necessary tool in many homes. What is the problem with schools? Why do most classrooms still look like they did fifty years ago?

Schools of education are slowly beginning to offer preservice courses in computing as an instructional tool. Many states now require some coursework for certification but the requirements are generally poorly specified. Often *any* computing experience is acceptable. What should be required is in-depth experience with computing in learning environments, using technology in practice teaching, and designing technology-mediated learning experiences. It is difficult, if not impossible, for a new teacher to introduce technology into her classroom if she has never seen technology used in a classroom. Modeling computer use in preservice instruction is a crucial factor, one that is often overlooked in the preparation of new teachers (Cunniff, 1990).

For two decades, schools have invested quite heavily in inservice programs. Teachers have had the opportunity to learn about technology. Despite the all-too-frequent "teacher-bashing" rhetoric in the popular press and sometimes even the profession, we know that teachers are educated individuals _ they know about learning. Given that, why is computing not having any noticeable effect on the quality of instruction in the schools? I propose that the answer to this question lies in educators' failure to understand innovation.

Understanding Innovation

The simplest model of innovation can be thought of as "grass-roots" innovation or turn-key teaching. In this model an individual _ usually a teacher _ tries out a new idea in her classroom. Her success is encouraged by the principal, and the enthusiasm engendered ultimately encourages the spread of the innovation to other classrooms. Actually this model is a good one because the innovation springs from *within* and its propagation is the result of "teachers teaching teachers" rather than as a result of the influence of outside experts. This is, in fact, the path that many innovations in instruction have taken to becoming institutionalized in a school.

However, this has not generally been a successful model for introducing computer technology to the classroom. Effective use of technology requires more than a single teacher with enthusiasm and a good idea. It requires such an extensive financial investment in hardware and software that teachers coming from preservice programs with training in the use of computers as instructional tools are often forced to revert to traditional instruction because of lack of necessary resources. Since teachers, in general, have no budgetary control, those interested in introducing computers to their teaching have to rely on others for support. The successful introduction of technology demands the active leadership and commitment of the school principal. Even if a principal cannot provide active instructional leadership in terms of computing, she must recognize its value and provide active support, both budgetary and institutional, for those teachers leading the introduction of the innovation.

The Principal's Role

As simple as it sounds, a crucial key to technology innovation is budgetary decision making. Certainly, that must be informed by knowledge about technology. The principal has both the leadership position and the accompanying institutional power to be a successful innovator. But this can only happen successfully if the principal has a broad knowledge of the possibilities offered by the new technology for the improvement of instruction.

I contend that if computing is ever to become successfully integrated into the learning and teaching process of a school, the principal needs to understand deeply the uses of computing for educational purposes. She also needs to be cognizant of the pedagogical implications, and curricular effects of using computing in the classroom and needs a thorough grounding in the research on educational technology and innovation. Ideally the principal should be a fluent user of computing for her own work. But what if this fluency is not there? What if the principal does not understand computing? Is the school doomed to traditional approaches?

If the principal at least recognizes the potential offered by computers and other technologies, she can support the introduction of that technology by adopting a shared leadership model and allowing an interested, committed teacher to take some leadership. Regardless of who leads the introduction and diffusion of technology in a school or school district, leadership is a necessary ingredient. Innovation does not just happen.

A Model of Administration

While I contend that the principal is (and should be) the overall instructional leader in a school, perhaps schools have become so complex that the time is ripe to redefine what we mean by "instructional leader." With schools being asked to take on more and more responsibilities, it may be reasonable to ask the principal to take a leadership role, providing intellectual and logistic support, but involving teachers in a far more active, substantive role. It may be time for principals to share both decision-making and leadership with interested and qualified teachers in a site-based management-like model. In this model, a qualified and interested teacher is given the responsibility to lead the school through the process of innovation diffusion. This model is particularly appealing when it comes to the introduction of computing because of the requirements computing makes in terms of both technical knowledge and the use of computing in the classroom. In fact, this is not a model that is totally foreign to schools. The "master teacher" model has been used on and off in education for decades. However, in this case, teachers will not just be asked to model good practice, they will be given shared leadership responsibility.

Such a model will require significant change in the behavior of many principals. If teachers have responsibility for technology innovation, they must be given budgetary discretion. They must have the freedom to make decisions that have long-range implications, and they will need the full, unwavering backing of the school administration. I propose that such a shared role may be key to effective implementation and sustainability of technology in classrooms.

Once the decision to share leadership is made, the decision making process in innovation will be gradual. Expecting overnight change is to doom the effort to failure. Moreover, it is critical that these instructional leaders — principals and teachers — understand and employ a model of innovation diffusion.

A Model of Innovation Diffusion

Despite the continual effort at educational change in the US during the 20th century, less than 10% of the reported research on innovation has come from education (Rogers, 1983). Interestingly, during this century, schools have been bombarded continually with decisions regarding the adoption or rejection of new ideas. There is, however, a large body of research concerning the introduction and diffusion of innovations to organizations. Everett Rogers has developed a model of diffusion of innovation based mostly on research in agriculture and medical care, primarily as related to work in developing countries, but this model is sufficiently general so that it can be applied to any discipline (Rogers, 1983). I would like to apply Rogers' model of diffusion of innovation to the situation faced by schools required to look at the adoption of computers and technology.

Rogers proposes that diffusion of innovation is based on a five stage decision-making model:

- developing *knowledge* of an innovative idea,
- forming an attitude *persuasion* toward this innovation,
- *deciding* to adopt or reject,
- *implementing* the new idea, and
- *confirming* this decision to implement.

Successful leadership in innovation requires intervention at each stage in this innovation-decision process. In schools the process begins when the individuals are first exposed to the technology and gain some understanding of how technology could function within their school.

Rogers emphasizes that existing conditions influence the readiness of an organization. He suggests that we must consider:

- previous and current practice,
- felt needs and problems within the organization,
- Innovativeness of the organization, and
- norms of the social system.

In a school, for example, while previous practice may be a hindrance to the acceptance of an innovation ("teachers teaching as they were taught"); dissatisfaction with student performance or the community's interest in technology may prompt the social system to seek change.

Often it is important to understand whether a need precedes *knowledge* of a new idea, or whether knowledge of an innovation creates a need for that new idea. Where technology has been adopted by schools, the answer is probably that both are true. There is a need to improve the way curriculum is organized and delivered and technology has been shown to provide teachers with capability not previously available. Schools come to a knowledge of computing because of their own needs and because they are aware of the success that computing has had in transforming other schools.

The innovation-decision process is essentially an activity of seeking and then processing information during which teachers and administrators are motivated to reduce uncertainty about the advantages and disadvantages of computing. Once aware of the possible uses of computing, questions such as "How does it work?" and "Why does it work?" begin to dominate conversation. These questions illustrate the other two forms of knowledge generated during the first stage in the diffusion process: how-to knowledge and principles knowledge.

How-to knowledge focuses on information necessary to use an innovation properly. *Principles knowledge* involves theory underlying how the innovation works. Rogers claims that a change agent's most valuable role is in creating awareness and how-to knowledge. In schools, however, without a link to principles knowledge awareness and how to knowledge fall short and result in adoption of surface-level features of an innovation rather than deep-rooted change. Computing has the potential, not only to change *what* students learn but to change *how* they learn. It is imperative that educators leading the adoption process create both how-to and principles knowledge for teachers.

At the *persuasion* stage, administrators and teachers form a favorable or unfavorable attitude toward computing. While the mental activity during the knowledge stage is mainly cognitive, this stage involves affective responses. The individual becomes more involved; this is where individual teachers actively seek information about computing. Innovation leaders must be totally aware that selective perception is critical in determining individual teachers' behavior at this point. Perceived attributes of computing such as its relative advantages, its compatibility with present practice, and its complexity are especially important.

All innovations carry some degree of uncertainty for the individual who is unsure of what the results will be for his situation. How will computing change what happens in his classroom? How will it change how he is viewed by his peers? The individual teacher needs to know that her thinking is on the right track in the opinion of her peers. During both the persuasion and the *decision* stages, individual teachers typically are motivated to seek innovation-evaluation information which helps reduce uncertainty about computing's expected consequences. Such questions as "What will be the results of using computing?" and "What will be the advantages and disadvantages in my situation?" are common. This type of information, while often available from formal sources, is usually sought by most individuals from their near-peers whose subjective opinion of the innovation is most convincing. The message here is quite clear: successful uses of computing in the classroom and successful users of computing are the best resource for convincing those in the decision process.

One means of coping with the uncertainty of an innovation's consequences is to try the innovation on a pilot basis. In fact, research shows that most innovations are not adopted without some trial on a probationary basis to determine usefulness in a specific setting. A small-scale trial is often part of the decision to adopt, and is important as a means to decrease the perceived uncertainty of the innovation for the adopter. In schools that have adopted computing, this use of a small-scale trial has been quite common both to reduce the uncertainty among teachers and to provide evidence of success to those controlling resources.

Because schools are organizations made up of many individuals, problems during the *implementation* stage are likely to be more serious than if the innovation was being adopted by an individual. In a school setting, only a part of the staff are involved during the early stages of the decision process. Once the implementation stage begins, however, the whole school is affected. When computing loses its distinctive quality of being something new and different in a school, the implementation stage is over and computing has become institutionalized. This is clearly not a stage that most schools have reached.

The *confirmation* stage begins shortly after the beginning of implementation and runs concurrently with implementation as the new users of computing seek reinforcement for the decision to use computing in the school. This stage carries on long after the implementation of computing has occurred and, in fact, may never end. Throughout the confirmation stage, individuals, particularly those responsible for the decision to adopt the innovation, seek to avoid dissonance or to reduce it if it occurs.

Human behavior change is motivated in part by a state of internal disequilibrium or dissonance, an uncomfortable state of mind that the individual seeks to reduce or eliminate. When an individual feels dissonance he will ordinarily be motivated to reduce this condition by changing his knowledge, attitudes, or actions. This dissonance reduction occurs at every stage of the innovation-decision process. If the innovation-decision process is to be valid, care must be taken that dissonance is not reduced by what Rogers calls selective exposure. This occurs when the evaluators seek only the information that they expect will confirm the decision to adopt the innovation. This type of behavior is, in fact, what makes it difficult to initiate change in the first place. Ideally, change should be a continuous process and this will only happen if school administrators honestly encourage dissonance.

Conclusion

Schools have historically been slow to change. This is true in part because change involves dissonance, acknowledging that the status quo is not meeting the needs of students nor achieving the school's goals. Resolving this dissonance requires that school leaders risk the upheaval that comes about during the change process. Change that results in growth will only occur with active leadership from school administrators and those empowered to share that leadership. When considering how to sustain the use of technology in classrooms, these leaders need not only a thorough understanding of computing and its implications for education and the educational process but also an understanding of how change occurs in an organization. In this paper I have presented a model of the diffusion of innovation which clearly defines the steps leading from first knowledge of a new idea to its confirmation as an institutionalized part of a schools practice. Positive, intentional growth requires active leadership through the stages of innovation diffusion. This can only happen if those charged with leading schools have an understanding of innovation as well as technology and schooling.

For a number of years now, we have been presenting pre- and inservice teachers with training in how technology works and in how to use technology to make instruction better. We have continually hammered the message that a school that includes computing as a part of its everyday practice will be a better school. Yet, we have not included study of change and innovation diffusion as a regular part of either teacher education or administrative certification programs. It is imperative that both teachers and administrators understand that schools can no longer be static institutions. Purposeful change and the sustaining of innovative practice requires that pre- and inservice training include study of the change process.

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A Handbook for Technology Implementation

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Why Technology Now?

The integration of technology into schooling has been proposed as a means of transforming the curriculum and the classroom to meet the demands of an information society in the twenty-first century (Papert 1980, 1988; Kurland & Kurland, 1987; Bork, 1980; Nickerson, 1988; Barker & Tucker, 1990; Means & Olson, 1994;Peck & Dorricott, 1994). Citizens of a global community require critical thinking and problem solving skills to accommodate an increasingly complex society. Those reformers who envision the reinvention of education, anticipate technology as their most powerful catalyst for transformation. While the debate is carried on in conjectural discussions, many elementary principals lack the theoretical background or the practical experience to initiate the introduction of technology into instruction within their school. Most literature has failed to investigate the decision making and commitment of changed teaching roles due to the integration of technology into the learning environment. Seldom is mentioned the decision making and support required of the principal administrator (Schuttloffel, 1993). The discussion here is an overview of material intended to develop an implementation handbook for elementary principals.

Two Objectives for Integration

In order to make the most appropriate rationale for the integration of technology into an elementary school, it is important to recognize two fundamental purposes for the integration of technology. The first is the function of technology as a powerful tool. The second is the vision of technology as a catalyst for massive educational reform.

As a Tool

The value of technology as a powerful tool is proposed by those individuals who draw a clear link between education and the workplace. Technology as a powerful tool has invaded business and industry while education appeared to have lagged behind unaware of its potential. Using technology as a tool does not require a change in the traditional processes of the classroom. Technology, particularly the computer, is used as an alternate strategy included by a resourceful teacher. The teacher decides the function of the tool in assisting classroom activity.

Compers are first used for administrative management purposes, then they become part of the curriculum in computer science courses. Later the computer is moved into the classroom as an instructional strategu. Packaged curriculum directs learning objectives while the classroom teacher remains out of the process. *Computers as tools* are not intended to transform life in the classroom or the structures of schooling; teachers and students maintain their traditional roles within classroom life. The technology remains a tool, like chalk or a textbook, used by the teacher as an additional strategy to maintain traditional life in the classroom. There are also proponents of technology integration who view hardware and software as tools to help manage classrooms. In this approach technology integration is operationalized in classrooms and schools as a sophisticated accountability tool.

The observable inclusion of technology in classroom life can be described as somewhat superficial and one-dimensional. However, it could also be characterized as the first stage of transformation.

As a Catalyst for Transformation

As a catalyst of massive educational reform, technology was proposed as the means to change the interaction between teacher and learner, the vehicle to change the activities of teachers and learners, and the context to change the relationship between teachers and learners (Willis, Johnson, & Dixon, 1983). If technology was successful in changing life in classrooms, the proposed result was transformation. The transformed life in the classroom ultimately dictated the transformation of the structures of schooling. Visionary reformers saw these stages of transformation as developmentally linked.

When technology integration serves as a catalyst to transform traditional life in the classroom, the integration of technology is proposed to expand learning productivity and possibilities (Bork, 1985; Pea, 1987). To transform life in classrooms, teachers and students face new interactions in a new classroom context. Recent research into the technology integrated classroom acknowledged the development of a new classroom context conducive to technology integrated learning (Salomon, Perkins, & Globerson, 1991). Technology that is catalytic intends to change life in individual classrooms, creating a new kind of classroom culture which exemplifies the second visionary purpose of technology integration.

There are those visionary reformers of school structure (Papert, 1980; Nickerson, 1988), who view technology as a change agent for massive system reform for schooling. Notably Papert (1988) focused attention on the fact that technology imposed upon the current educational system was ineffective in attaining the effect of intrinsically motivated life long learners. To obtain the desired objectives of educational transformation, structural change of the entire school was a requirement. Structural change is not easily instigated by teachers. Transformation of the structures of schooling must be supported, if not instigated, at the administrative level.

Where to Begin?

Our discussion of the implementation of technology begins appropriately with the first purpose for integration, that is technology as a tool. Without refuting or validating the relative merits of the transformational visionary versus the technical purpose, implementation begins with the same process. However, it is important for principals to remember that choosing a clear purpose for the integration will determine its successful implementation.

Once the purpose of implementation is determined, most research on the implementation of technology in schools stresses the importance of realistic expectations. The safe assumption is that the less technology is seen as an intrusion into traditional teaching, the more accepted it is. That is a basic explanation for the popularity of the computer lab, with the technician/computer teacher.

In order to continue our discussion of implementation, several possible scenarios for implementation are described. The purpose of this activity is to make the principal aware of the wide variety of technology usage going on in schools today. Later the discussion will return to add details to the implementation of these possibilities.

Possibility 1: Computer Labs. The decision to begin computer implementation with a computer lab and a trained computer science teacher is extremely popular and successful. The implementation of this program has some obvious positive qualities. For instance, the computer teacher has the technical knowledge necessary to choose the hardware and software to begin the program. While most computer labs began in high schools, with computer science classes focusing on the technical side of computer usage, today computer labs are found in all levels of schools. The classroom teacher is typically supportive of a computer lab approach for a variety of reasons. First, the faculty does not have to become proficient in computer usage. They do not have to gain any new skills and traditional classroom activity is not affected by the program. An additional benefit for the classroom teacher is the possibility of an extra planning period while students are with the computer teacher. This is often the choice of preference for classroom teachers.

As a principal however, the computer lab choice has some major stumbling blocks. First, a lab requires the acquisition of ten or more hardware units. There is also the problem of classroom space for a lab. Finally, there is the expense of an additional teacher trained in computer science with technical knowledge. Many administrators determine that acquiring a lab is too expensive to implement in the beginning stages of technology usage. In earlier times, particularly in elementary schools, the education of students in computer science or literacy skills was seen as a frill when finances were tight. Later however, as instructional curriculum was developed, other functions for the computer in elementary school were generated.

Possibility 2: Computers in the Classroom. An option that many administrators choose for the beginning stage of technology implementation is to place a single computer into each classroom. The intent of the program is to slowly acquaint teachers with the computer by using it at their own pace. While the possibility is certainly well-intentioned, the reality is that one computer in a classroom of twenty to thirty students leads to more of a problem for teachers than a tool. There is also the danger that while there is a computer in the classroom, the teacher may not have the initiative to learn how to use it or the confidence to train the students. This situation also placed the burden of evaluating and choosing software on the shoulders of an untrained teacher. That is not to say that this possibility never works, there are always those ambitious teachers who rise to the challenge of providing an opportunity for their students. It can only be said that one computer in the classroom is only better than no computer at all.

The clear attraction for the principal to the second program is that there is no additional concern for space acquisition and no extra finances necessary for a computer teacher. In this program the major expenses are in the hardware and software. The negative aspects of this choice should not deter a principal who sees this as the only means to introduce technology into the school. Minimal exposure and creative planning can give students a hint of technological experience before moving on to settings where there are more opportunities.

Possibility 3: Changing the Purpose of the Computer Lab from Computer Science to Content Curriculum. Most computer labs that were incorporated into elementary schools were used for a category of computer programs generally referred to as CAI or Computer Assisted Instruction. These programs heralded the beginning of vast amounts of "educational software," much of which was no more than workbooks on a monitor screen rooted in rote learning. The dubious quality of these programs was overlooked due to their straightforward purpose and the novelty of educational technology. These programs were designed to teach basic skills. Many of these programs were popular with teachers because they required virtually no instructional preparation to use and students could work relatively unsupervised. Such software is often described as "stand-alone" for this reason. Consequently the computer lab teacher could have no mathematics teaching experience, but could supervise a lab full of students working on math CAI. These programs could be used on solitary computers in the classroom with a teacher having little computer literacy or experience.

Possibility 4: Transforming Life in the Classroom. In 1980, Seymour Papert wrote a book entitled, *Mindstorms*, describing a vision of schooling transformed by technology. Papert and his researchers raised the possibility of changing the processes of teaching and learning through the power of technology. From that original dream sprang the visionary roots of educational reform based in technology. Within that vision, the purpose for technology integration into the classroom becomes considerably more complex. The goal of the vision is the reinvention of education.

Within the framework of this possibility the role of the teacher shifts from observing to implementing technology usage. The traditional role of the teacher is impacted by a learning process that no longer places the teacher at the center of learning, but as a facilitator who guides students down a path of discovery and investigation. The classroom/content teacher uses the computer lab as a means of opening doors for students. The tools of the transformed teacher are various forms of technology with emphasis on the computer with the modem and CD-ROM. The teacher becomes the map maker while the student is the explorer.

Research dictates that the transformed model of technology implementation has only been successful under carefully monitored conditions. One of those conditions is the support of the principal of the school who must understand that changing the traditional teacher to the transformed teacher will change life in the classroom and ultimately, life within the entire school. Isolated classroom teachers do not have the resources nor the power within the school to transform teaching and learning without a committed principal. Consequently any principal who chooses the fourth possibility must do so knowing that school life will never be the same again.

The visionary possibility for schools seems within grasp today compared to 1980. Students carrying laptop computers, connecting to research centers around the country via the modem is a practical possibility usually only impeded by finances and traditional beliefs about the role of teacher and the processes of learning. The other impediment to transforming life in the classroom is the lack of preparation for teachers to fulfill their new roles. Technical knowledge and a broad base in content areas assists the transformed teacher with decision-making. The following discussion addresses some of these issues.

Selling Technology to the Staff

Crucial to the success of the use of technology in schools, even at the most basic tool level, is teacher commitment. Occasionally there will be a teacher on staff who actually initiates the technology program in a school by asking the principal about offering computer experience. Other times a principal may be using a computer for administrative purposes and recognizes the possibilities within the classroom. Occasionally the principal begins the investigation of a computer class due to pressure from parents to be competitive with other schools. In today's educational climate computer literacy and facility is no longer considered a luxury but the sign of a sophisticated, 21st century educational curriculum. Thus many principals are under considerable pressure to initiate the usage of computers in their school.

After a principal recognizes the two potential objectives for using technology, she understands that the faculty requires some technical knowledge of the computer as a tool. A wise principal will educate herself first about the various technologies available by visiting other schools and asking for an honest appraisal of their choices. An equally productive move is for the principal to invite faculty members to begin acquiring information about technology, particularly the computer. The principal may invite those individuals who use computers to become part of an exploratory committee, but she should also offer the opportunity to those faculty who wish to begin their own computer literacy. Very often the inclusion of those lesser informed staff members can be helpful as they make no assumptions and ask basic questions. The group of faculty members involved at this early stage of implementation must recognize that their task is huge and their commitment to the long haul implementation is key. Their participation at this early stage is that of explorer and investigator.

In the event that the principal has a vision of transforming traditional teaching and learning within her school, these faculty members will be the first to become informed of that vision. The principal must make clear that the technologies available are for the ultimate use of all staff and students. At this stage however, the focus is on the primary use of the technology, usually referring to the computer, as a tool.

The selling of computer technology to an individual teacher can be approached in several ways. The easiest is the least intrusive and the most useful. Many schools begin with technology in the central office. The secretaries use technology for record keeping and word processing. Just the presence of the computer in the office used by previously untrained staff makes an impression on the faculty. As these staff have more ability to use the technology they will happily advertise its facility to others. The extension of that arrangement is the usage of computers for record keeping by teachers. The many gradebook programs available are a time saving device that can be "sold" to many faculty members. Once this is accomplished, moving the faculty into using the computer in their classroom becomes less onerous as they are comfortable with the hardware already. In this stage of implementation exposure becomes a key element in selling the technology as a tool.

A Handbook for Principals of Catholic Elementary Schools

The purpose of developing a handbook for principals of Catholic elementary schools is straightforward. The reality is that many administrators in these schools have few resources to assist them in making decisions regarding technology. Unlike their public school counterparts with central office staff to assist them or perhaps make the decision, Catholic school principals are handicapped by the lack of bureaucratic supports and financial resources. Therefore the acquisition of current, practical information that can direct the principal through a step by step process of implementation is a valid need.

The projected handbook explicates for principals the basic premise that the process of technology implementation is as important as the ultimate objective. First, principals must acknowledge the lack of teacher preparation to use the computer as a tool. Next the principal must also recognize that current literature is full of descriptions characteristic of both the objective of the computer as a classroom tool and the computer as a catalyst for educational reform. Finally, the integration of technology into life in the classroom for visionary purposes will attack the underpinning beliefs of traditional teaching. This is no small task for a principal to accomplish with a faculty. A principal must lead the implementation of technology if the final objective is to bring a fundamental change to life in classrooms.

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Technology for Instructional Leaders: A School-University Collaboration

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Educational technology holds great promise in the quest to improve schools and their instructional delivery (David, 1991; Dwyer, 1991; Means, 1994; Newman, 1992; O.T.A., 1988; O.E.R.I., 1993; Reigeluth and Garfinkle, 1992; Scrogan, 1993; Sheingold, 1991). Unfortunately, most school leaders have not had technology training and are not prepared to make informed decisions on the multitude of technology issues that must be addressed in education (Casey, 1993). As a result, most school administrators lack a vision which includes technology as an integral part of their school's instructional program. If instructional technology is to become successfully integrated into the classroom, the school principal needs to have first-hand knowledge and experience using instructional technology. This paper describes a 1994 study examining changes in school administrators' attitudes toward their leadership role and the use of instructional technology in the classroom as a result of participation in a staff development program designed to help them become more supportive, well-versed technological leaders in their schools.

Background of the Study

Roswell Independent School District, in Roswell, New Mexico, has had a technology initiative for the past three years. The community, Board of Education, administrators, and staff have expressed belief that, in order for our students to be prepared for the challenges of the twenty-first century, they must be proficient users of technological tools.

In October 1993, 425 staff members responded to a Technology Needs Assessment. In that survey, more than half (57%) of the staff classified themselves as non-users or novice computer users. Teachers and administrators did, however, desire an increase of student use of computers and staff development opportunities in technology. The staff expressed a strong belief in the positive impact of computers. Ninety-four percent (94.1%) said that they thought that computers can have a positive impact on students' learning and/or achievement. Almost eighty-nine percent (88.7%) agreed that computers can have a positive impact on the way they work or teach. Eight-seven percent (87%) of the respondents expressed an interest in training.

If a large percentage of teachers in the Roswell school system believe in the positive benefits of computers and desire additional training on computer use, then why are computers not used more in the instructional program? Some possible reasons for limited use of technology are lack of hardware, lack of software, fear, stubbornness. Mary-Alice White (1989) suggests another possibility:

> …Almost all other work settings continue to be ahead of education in their applications of technologies to their functions. Many people … complain that teachers do not use technologies enough in the classroom and wonder why. Some would answer: because our teachers are too rigid, too traditional, too unwilling to innovate, downright stubborn, or scared to death. The more enlightened view is that behavior which persists must make sense to teachers. Why does it make sense? because teachers are caught in an evaluation system that really only

> rewards teaching the traditional skills … If I were a teacher, working with too much curriculum and too little time in which to teach it, I should begrudge every minute taken away from teaching that really pays off… Who can blame them for behaving like intelligent organisms, putting their efforts where they pay off? (pp. 4-5)

The Roswell Independent School District had made an initial response to the challenge of incorporating technology into the instructional program by developing an instructional technology long-range plan and curriculum guide. Workshops and summer technology institutes had been offered to teachers. Still, too many computers were sitting in the back of the classrooms gathering dust.

In the fall of 1993, Pam Tipton, Director of Instructional Programs in charge of staff development for the District, and Dr. Christene Bennett, a staff development specialist and Assistant Professor of Education at Eastern New Mexico University collaborated in the development and implementation of a staff development program designed to promote technology integration in schools K-12. The authors conceptualized, planned, organized, and delivered instruction.

As a first step in program development, the authors reviewed the current staff development literature on integration of instructional technology into school programs. Studies showed that the majority of school administrators had little technology training and were not fluent users of technology (Bozeman & Spuck, 1991; O.T.A. 1988; Walters, 1987; Witten, Richardson, & Prickett 1990).

As a second step in the decision-making process, the authors reviewed the District's technology plan. After thorough consideration of District technology goals, a review of results of a District-wide technology needs assessment, and discussion of current staff development findings, we decided that the strongest impact on technology integration in classrooms would result from first training administrators.

We created a 14-week staff development program focused on instructional technology for school principals and other instructional leaders within the District. The partnership program, fully supported by both the School District and University, included hands-on training with computers, review and instruction in the use of educational technology in the classroom, and the examination of leadership issues in promoting technology in education. Nineteen school administrators participated in the training on a voluntary basis. As an incentive, the school district paid for 3 hours of graduate credit for each participant.

Purpose of the Study

The purpose of the study was to produce descriptive data about the context, activities, and perceptions of school administrators participating in the program. The study examined changes in school principals' attitudes and beliefs toward personal/professional use of technology, use of instructional technology in the classroom, and perceptions of themselves as technological change agents.

Data Collection and Analysis

This study employed both quantitative and qualitative methods. Pre- and post program attitude surveys were administered using a modified version of the Computer Attitude Scale (Loyd & Gressard, 1985). Pre- and post-program focus group interviews were also conducted. Additionally, reflective journal entries were completed by administrators on a weekly basis during the 14-week training period.

Results of the Likert-scale attitude surveys were analyzed statistically using paired t-tests to determine if any statistically significant agreement was reached and if any statistically significant differences in attitudes existed between pre- and post-program groups. Analysis of both focus group and reflective journal data began with categorizing and coding open-ended responses to questions. Categories were described and the frequency of each category was determined. Data were then coded according to emerging patterns, resulting in a narrative account that described and explained the process of staff development within its unique context (Yin, 1984).

Findings of the Study

Results of the study were based on the use of both quantitative and qualitative methods. Data were collected and analyzed to produce descriptive data about the context, activities, and perceptions of program participants.

Program Participants

An invitation to participate in the program was extended to all 44 administrators within the District. Nineteen administrators responded and participated in the training. They included three Central Office administrators (Superintendent, Assistant Superintendent for Instruction, and the Coordinator of Media Services), five high school representatives (two principals, two assistant principals, and one department chair), one middle school principal, and ten elementary representatives (nine principals and one Bilingual Specialist for Title VII).

The participant group was representative of the Roswell Independent School District norms for age, ethnicity, and years of administrative experience. The average age of participants was 46 years, The group consistent of eight females and eleven males. Nine participants identified themselves as Hispanic, eight described themselves as White, and one was of American Indian descent. The years of administrative experience ranged from one to 28, with an average (mean) of 12 years. Based on focus group interviews and other information gathered during the first class session, we found participants to have technological understandings and skills ranging from novice to advanced.

Program Instruction, Content and Processes

The program, which commenced in February 1994, included 14 weekly two-hour sessions held at a high school Macintosh Lab. A 4:00-6:00 p.m. weekly time-frame was established in response to administrators' preference. Pam Tipton, Christene Bennett, and Jerry Bennett, a technology consultant for the District, developed and delivered the instruction, which included hands-on training with computers, review of the role of and possible delivery strategies of educational technology in the classroom, and the examination of leadership issues in promoting technology in education.

The sessions began with hands-on, individually paced practice at the computer. Each administrator was encouraged during the first class session to choose one of the lab's 24 Macintosh SE computers to "call their own" for the duration of the program in an effort to increase comfort levels. The first hour of each session was devoted to individual instruction in the use of ClarisWorks, a District-adopted integrated software program incorporating graphics, word processing, data base, and spread sheet applications. As the sessions progressed, personal application of the software program was encouraged.

The second half of each class was devoted to lecture and discussion of selected topics including:

- Technology and learning processes (Bloom's Taxonomy, Maslow's Theory, learning styles, technology anxiety)
- Technological learning contexts (one-computer classroom, distributed mini-labs, labs, networked systems, integrated learning systems)
- Hardware and software management, legal parameters of technology use including copyright laws
- Integration of technology into the curriculum and instruction, including review of sample software programs
- Use of telecommunications in education.

During two sessions, administrators lead small group discussion of self-selected literature on technology. Other assignments required administrators to develop a technological mission statement and needs assessment for their school, and to design a technology integration plan for their site.

Changes in Attitudes toward Computer Courses

Several statistical tests were performed on quantitative data collected on pre- and post-program attitude surveys. Statistically significant differences were found in a number of areas. When all respondent statements were compared using paired t-tests, values on two statements had significantly changed. Post survey results were more in agreement that "Computers do not scare me at all" and "It wouldn't bother me at all to take computer courses." Participation in the program made the idea of being involved with computers more agreeable to administrators.

When survey results were compared by sex and ethnicity, statistically significant findings were also obtained. The White (non-Hispanic) and Hispanic groups gave statistically different responses on four statements on the pre-test and two different statements on the post-test. White pre-program participants reported being more in agreement that "Knowing how to work with computers will increase my job possibilities" and "I have a lot of self-confidence when it comes to working with computers", and less in agreement with "I will do as little work as possible with computers" and "Anything a computer can be used for, I can do just as well some other way" than Hispanic respondents.

In post-program results, White respondents reported less agreement with "The challenge of solving problems with computers does not appeal to me" and were more in agreement with "When there is a problem with a computer application that I can't immediately solve, I would stick with it until I have the answer" than Hispanic participants.

Male and female respondents gave four statistically significant responses on the pre-test and one on the post-test. Female respondents were less in agreement with the statements "I'm no good with computers", I will do as little work with computers as possible", and "Anything that a computer can be used for, I can do just as well some other way". They were more in agreement with "If a computer problem is left unsolved at my school, I would continue to think about it" than male participants on the pre-program surveys. The only significant difference on the post-survey results was that female respondents reported less agreement with "Working with computers would make me very nervous" than male participants.

The sample size used for these statistics is extremely small and therefore implications drawn from these results cannot be extended reliably to a large population. Statistical findings indicate that participation in a technology course tends to "level the play field" in that the differences between ethnic and gender responses decreases. Also, it appears that participation in a technology course tends to reduce anxiety about computers and computer courses.

Changes in Attitudes toward Use of Computers as a Personal/professional Tool

Analysis of reflective journal and focus group data revealed changes in administrators' beliefs and attitudes toward computers as a personal and professional tool centered on specificity of use. When the program began, typical comments were, "I hope to prepare better documents and reports using the program," and "Will be thinking of ways to put it to use..." After eight weeks of instruction, participants discussed planned use of specific software to be incorporated in instructional units, charts and graphs generated by the spread sheet for showing progress and comparisons. For instance, one administrator responded, "I loved working on the spread sheet - first time! Anxious to apply what I learned to an area in school. Hadn't done charting before! How EASY!" Once administrators developed an understanding of technology uses, they began to think in terms of how technology applied to their personal and professional roles.

Changes in Attitudes Toward Use of Technology in the Classroom

Reflective journal and focus group data also showed administrators' growth in empathy for teachers using technology in the classroom. Many individuals experienced personal frustrations expressed by comments such as, "I work too slowly to get very far on the computer - I'm computer learning disabled" and "Makes me realize how long it may take a staff to just get to comfort level!" Also, as the program progressed, administrators began to consider possibilities for uses of technology in the classroom. One administrator responded, "The world of information is made more accessible through Internet. This gives me insight into what will soon be norm in our classrooms". Another administrator wrote, "'Closed' software is so limiting! How interesting to discover that my expectations for computer use have changed dramatically."

Changes in Attitudes Toward Leadership Roles

Reflective journal and focus group data indicated changes in administrators perceptions of their role as instructional leaders. For example, one participant commented "I believe this case group will become catalysts for technology use in the RISD." Another administrator responded, "...we will be able to lead our staff in the new technological mode. I hate to not be able to 'practice what I preach.'" One participant summarized the view of many by stating, "Reading the literature has helped me to remember to focus on the importance of taking a holistic view to effecting change in staff. A successful plan for implementing technology must assist teachers to grow and self actualize, bearing in mind that this is a complex interaction of environmental factors such as school climate, collaboration and involvement of teachers, and extensive training that meets the affective and cognitive needs of teachers."

Conclusions and Implications

Technology inservice training for school administrators is a critical starting point in staff development programs designed to promote technology integration into the classroom. As a result, teachers and students will be better supported in their efforts to teach and learn within a technological paradigm. This study lays a foundation for future research as well as the development of staff development programs designed to prepare school administrators to function as technological leaders in their schools.

Program developers should consider the following seven guidelines to help principals and other instructional leaders become more supportive, well-versed technological leaders in their schools:

- Strive to build collaborative networks between schools and universities in the development of administrator training programs.
- Provide technology inservice training for school administrators as a staff development priority. As a result, teachers and students will be better supported as they attempt to learn new technological skills.
- Provide staff development which is individualized to meet the needs of each participant. Each person, regardless of their role in the district hierarchy, learns at a different rate and in a different style.
- Offer personal support and encouragement to each administrator involved in the learning process. It is important to consider the psychological risks and pressures that may haunt administrators as they venture into a new learning situation, especially since these individuals are often viewed, and see themselves, as someone who should know all. Psychological safety is a key to effective staff development. Fears of ridicule and feelings of inadequacy reduce an individual's comfort level and inhibit cognitive as well as affective growth.
- Include hands-on training in your staff development program. Technology inservice training for school administrators should include first-hand experience with computers, review and instruction in the use of educational technology in the classroom, and the examination of leadership issues in promoting technology in education
- Plan for on-going program evaluation, which is critical to the success of your technology integration program. Formative and evaluative feedback are important components to a successful program.
- Consider staff development for technology integration as a process that will take time. A one-shot workshop for teachers or administrators will not result in the application and integration of new technology skills into classroom practice. So consider your resources in terms of time, money, and effort and plan your technology integration program accordingly. The nature and complexity of your technology goals, as well as the training activities selected to achieve your objectives, must be considered within the context of your school district.

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Assessing Teachers in a Telecommunications Initiative Using the Concerns-Based Adoption Model

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The Concerns-Based Adoption Model (CBAM) was used as part of a multiple-case study design to describe the developmental levels of participants in a telecommunications initiative, the Electronic Academical Village Project. Change facilitators used CBAM to identify and correct training and support procedures and to address the circumstances and experiences that led some teachers to incorporate telecommunications into their teaching practices while others did not.

The Concerns-Based Adoption Model, designed by Gene Hall and his associates, is a unique way of looking at the change process. Change occurs within individuals. Hall and Hord (1987) explained that when CBAM is used, change facilitators and teachers work together to address evolving needs. This permits change facilitators to assess implementation procedures and redesign interventions.

The Concerns-Based Adoption Model

There are two components to the Concerns-Based Adoption Model, the Stages of Concern and the Levels of Use (Hall and Hord, 1987). The Stages of Concern "relate to the feelings, perceptions, motivations and attitudinal dynamics of individuals as they first become aware of an innovation, approach to use and gradually become increasingly confident in their use of the innovation" (Hall, 1979, p. 4). The Stages of Concern are: Awareness, 0; Informational, 1; Personal, 2; Management, 3; Consequence, 4; Collaboration, 5; and Refocusing, 6.

A teacher at the Awareness Level (0) has little concern about the innovation. The Informational and Personal stages (Levels 1 and 2) refer to how individuals' view the innovation in regard to themselves. The third level, Management, refers to how individuals are managing the innovation. At Level 4, Consequence, teachers are concerned about the impact of the innovation on students. At Level 5, Collaboration, teachers focus on collaborating with others in regard to use of the innovation, and at Level 6, Refocusing, teachers discuss ways to change or replace the innovation.

The Levels of Use provide insight into how teachers are using the innovation. The Levels of Use are: NonUse, 0; Orientation, 1; Preparation, 2; Mechanical, 3; Routine, 4A; Refinement, 4B; Integration, 5; and Renewal, 6.

The 0 Level, NonUse, indicates that the innovation is not being used, read about, or discussed. A person at Level 1 is seeking information and a person at Level 2 is preparing for use. Levels 0, 1, and 2 are all stages of non-use and it isn't until Level 3, Mechanical Use, that the innovation is actually tried for the first time. Individuals at Level 3 focus on the short term, day-to-day use of the innovation and often do not see the big picture. As they become comfortable, they move to Level 4A, Routine. The next Level, Refinement (4B), occurs when teachers begin to think about refining the use of the innovation to maximize the effects with students. This might involve gathering additional materials or attending inservices. Teachers at Level 5, Integration, decide to work in collaboration with other teachers to increase the impact of the innovation and in Level 6, Renewal, teachers reevaluate the use of the innovation and explore alternatives by examining new developments in the field. Data for the Stages of Concern and Levels of Use are collected through guided interviews.

Background of Study

In 1991, educators at the Curry School of Education at the University of Virginia began developing ideas for integrating telecommunications into the instructional practices of public school teachers using Virginia's Public Education Network (Virginia's PEN). Several teachers were invited to participate in a telecommunications project called the Electronic Academical Village, which was based on Thomas Jefferson's vision for the Academical Village he created, the University of Virginia.

The objectives of the Electronic Academical Village Project were to increase teachers' effectiveness in the delivery of instruction through the use of telecommunications, to improve educational experiences by providing a real-world perspective, and to provide a system by which teachers could share data, information, and resources. The "village" consisted of several different menu options called "pavilions," and resources were grouped by subject.

Participants in the Electronic Academical Village Project were teachers who had been recommended by their school division as being positive toward technology and innovative in their teaching practices. Participants had access to a Macintosh computer, a modem, and a phone line. They received monetary compensation for attending training workshops.

The Electronic Academical Village Project spanned two years (1991-1993). Based on the CBAM model, this study investigated the Stages of Concern and Levels of Use of participants in the project. The results helped determine the kinds of training and support needed to sustain this project and others like it.

Methodology

Case studies of six teachers who were members of the Electronic Academical Village were developed to determine the Stages of Concern and the Levels of Use of each. Cases consisted of data from interviews with the teacher, his/her principal, and the facilitator assigned to the teacher from the Electronic Academical Village Project.

Selection was based on the teachers' levels of participation in project activities. Three had relatively high levels of participation, as demonstrated by their frequent contributions to existing project conferences, their initiation of additional networking activities, and their participation in other Virginia's PEN conferences. The other three were selected based on their lack of participation in the Electronic Academical Village Projects or other Virginia's PEN Conferences. All were from different school divisions and were working with different facilitators. Each was an elementary or middle school teacher in a public school in Virginia, had an account on Virginia's PEN and had access to a computer, a modem, and a phone line at school.

Data Collection

Interviews were used to gather data on how participants were using Virginia's PEN in their classroom and what contributions (if any) they had made to the conferences of Electronic Academical Village Project. The teachers were asked to address their general reactions to Virginia's PEN and the Electronic Academical Village Project and describe the impact telecommunications was having on their students. Principals were interviewed to uncover extenuating circumstances that might be affecting teachers' use of Virginia's PEN and their participation in the Electronic Academical Village Project. Interviews with facilitators were used to gather information on the kinds of support and training the teachers had requested, how they had responded to requests, and how they were promoting use of the network.

The data provided an understanding of the concerns of teachers involved in the Electronic Academical Village Project and how these concerns affected their levels of use. This information also provided insight into the circumstances and experiences that either encouraged of inhibited participation. All interviews took place between February 1 and May 1 of 1993.

Data Analysis

The content analysis format developed by Newlove and Hall (1976) was used to analyze the data for the Stages of Concern based on the teachers' responses to the questions asked in the guided interviews. From preliminary analysis of participants' responses, a broad indication of the Level of Use emerged. To narrow and refine the assessment of each user's Level of Use, a framework developed by Hall, Loucks, Rutherford, and Newlove (1975) was used. This framework, referred to as the Levels of Use Chart (LoU Chart), contains indices and decision points to more accurately assess Levels of Use.

Findings

Case 1 - High User Anna Adams.

Anna, a fifth grade teacher, taught in a resource-rich environment. Most of the teachers in her building had computers, modems and phone lines in their classrooms. She also had competent on-site technical support, a principal who strongly supported the use of technology, and a project facilitator who was supportive and helpful.

This was Anna's second year of involvement in the Electronic Academical Village Project. She and a small group of students participated in an online science project to determine how soil content affected the growth of plants. After experiencing success, she was ready to conduct telecommunications activities with several groups at once. She also expressed a desire to initiate online projects to meet curricular needs.

Anna was attempting to master the tasks required to use telecommunications and was becoming more comfortable incorporating telecommunications into her teaching plans. She was also beginning to explore other possibilities for use. Her comments indicated that she was at the Mechanical Level of Use, Level 3, but moving toward the Routine Level of Use, Level 4A.

Anna was concerned about using the computer for whole-group instruction, the amount of time it took to teach students to use telecommunications, and students' poor keyboarding skills. These concerns focused on managing the innovation and suggested that she was at the Level 3, Management, Stage of Concern.

Case 2 - High User Betty Brown

Betty, a third grade teacher, taught in a school where the use of technology was considered to be important but not required. Several teachers had computers in their classrooms, but only Betty and her grade partner were using telecommunications. They shared a dedicated phone line which was funded by the PTA. Betty was in her second year of involvement with the Electronic Academical Village Project.

Betty was unique because rather than change her teaching practices to conform to available resources on Virginia's PEN, she changed the network to fit her needs. She initiated the va.pen.elem.books conference to provide students throughout the state with interactive learning experiences to strengthen reading, writing, and critical thinking skills. In this conference, students corresponded with story-book characters such as Ramona Quimby (from *Ramona Quimby, Age 8*, by Beverly Cleary) and Willy Wonka (from *Willy Wonka and the Chocolate Factory* by Roald Dahl). She collaborated with others to establish additional electronic conferences including "Ask Mr. Science" and the Multicultural Pavilion, which housed stories and activities from diverse cultures. She also proposed that the Math and Science Pavilion be separated to house discussions pertaining to each discipline. Betty was evaluating the quality of the Electronic Academical Village Project, proposing changes, and seeking alternative ways to use the network. This indicated that she was at the Level of Use 6, Renewal.

Betty was concerned about a lack of technical and instructional support available to the participants of the Electronic Academical Village Project. A lack of conference moderators was also a concern because some people posted inappropriately. These haphazard postings forced readers to make sense of discussions on their own. Betty's frustration over incorrect postings led her to become a conference moderator. Finding other users at her level was also a concern. Contact with other high users would renew and assist her as she searched for new ways to empower students to learn. Her concerns over how the network was being used and her actions to improve it indicated a Stage of Concern of Level 6, Refocusing.

Case 3 - High User Catherine Caprio

Catherine was in her first year of involvement with the Electronic Academical Village Project. She was a resource teacher for gifted students at a middle school described as being "state of the art." Four computer labs were used to produce the school newspaper and literary magazine, create multimedia presentations, and use robotics. Every classroom had computers. However, there was only one modem, and it was located in the library. The principal did not want additional modems because they would tie up existing phone lines.

Instruction was based on inclusion, and Catherine worked with students and teachers in their classrooms. She participated in telecommunications activities by assisting other teachers as they integrated projects from the Electronic Academical Village Project into their curriculum. For example, sixth-grade classes participated in the Recycle Challenge by measuring the amount of recyclable paper they discarded each week. The modem at school was not easily accessible, so Catherine posted the data from home. She was also planning to involve sixth-grade classes in other telecommunications projects. Based on the information collected, Catherine appeared to be at the Integration Level of Use, Level 5 because she was using Virginia's PEN to collaborate on projects with other teachers at her school.

Catherine was at the Level 3, Management, Stage of Concern because her concerns focused on how to use telecommunications with the available resources. She also mentioned that it was difficult to logon to Virginia's PEN during school hours because the line to the local node was usually busy. Because of this, Catherine reported that it was almost impossible to use Virginia's PEN with groups of students at her school.

Case 4 - Low User Doug Duncan

Doug taught fifth grade at a newly-opened school and was in his second year of teaching. This was his first year of involvement in the Electronic Academical Village Project. The school had a lab with 25 computers, and classrooms were equipped with a computer and modem. The computers were networked and supported by an in-house server that contained many different types of instructional software. Doug was comfortable using telecommunications and operated an electronic bulletin board service. He had a computer, a modem and an undedicated phone line in his classroom, along with a laser printer and a LCD panel.

Doug had little involvement with the Electronic Academical Village. He did not attend the planning sessions, had posted only once to discussions associated with the Electronic Academical Village, and had ignored e-mail from other project members. He said that he wanted his students to participate in projects in the Math and Science Pavilion, but never requested any information. When asked if he was planning to incorporate telecommunication activities into his teaching plans in the future he said, "Maybe next year." Doug knew how to use telecommunications, but chose not to participate in the Electronic Academical Village. Because of this, he was at Level of Use 0, NonUse.

There were several factors that may have contributed to Doug's NonUse, and he addressed these as concerns. His phone line was undedicated, and he was limited to thirty minutes of online time per day. He also felt that Virginia's PEN was not user friendly and offered suggestions for creating an online help feature. He did not think the compensation he received for attending the workshops of the Electronic Academical Village Project equaled the amount of time required to participate. These concerns implied that Doug was aware of Virginia's PEN and had enough information to use it. However, lack of access and an opinion that the network was inadequate inhibited his use. Because of this, he was at the Personal Stage of Concern, Level II.

Case 5 - Low User Emily Edwards

Emily taught math and science to fifth grade students and was the computer support person for her school. She was in her twentieth year of teaching, and this was her second year of involvement with the Electronic Academical Village Project. Emily's school was new, and she described it as "state of the art." Each classroom had a computer and a modem. There were two dedicated phone lines, one for the office staff and one for teachers.

Emily was not incorporating any telecommunications activities into her teaching practices. She had not kept an agreement to participate in an online science experiment, and she ignored e-mail from project members. She admitted that she had not logged onto Virginia's PEN to seek information about ongoing projects. Emily was at the Level 0, NonUse, because she was not involved with any of the activities of the Electronic Academical Village and had no plans to begin incorporating telecommunications activities into her teaching practice in the future.

Emily was concerned about using telecommunications with her class because she had one computer and twenty-four students. She wanted either an LCD panel or more computers. She also wanted a computer at home, but felt that they were too expensive. Emily thought some of the activities in the Electronic Academical Village Project did not correspond to the curriculum for Grade 5, but she did not attend planning meetings or initiate activities on her own. Based on her lack of interest in the activities of the Electronic Academical Village, she was at the Awareness Stage of Concern, Level 0.

Case 6 - Low User Frances Frost

Frances was a middle school science teacher in her third year of year of teaching. She taught sixth-grade students. This was her first year of involvement in the Electronic Academical Village Project. Her school was about twenty years old. There were two computer labs and five computers on rolling carts. There were three modems, one in the computer lab, one in the media center, and one in Frances's room.

Frances was at the Orientation Level of Use, Level 1, because she was in the process of acquiring information on how to use Virginia's PEN and making preparations to begin use in the near future. As a science teacher, she frequently used a "hands-on" approach for instruction and was interested in participating in the projects in the Math and Science Pavilion of the Electronic Academical Village. Her lack of technical expertise inhibited her use of telecommunications, but she had requested help and was looking forward to using telecommunications activities with her students.

Frances was concerned because her school had provided her with expensive equipment, and she did not know how to use it. Frances wanted to learn how to use the telecommunications software to connect to Virginia's PEN, and she wanted to talk with members of the Electronic Academical Village Project about how they were using the network. Because Frances was interested in using telecommunications with her students and was gathering information, she was at the Informational Stage of Concern, Level 1.

Results

The Concerns-Based Adoption Model was used to determine how participants in the Electronic Academical Village Project were using telecommunications in their classrooms. Based on the findings, the Planning Team of the Electronic Academical Village Project decided to change the types of technical training and instructional support they provided to participants. At training workshops, high users were encouraged to share ideas with each other and initiate challenging online projects. Novices were trained in small groups and encouraged to participate in structured activities/projects designed to provide success. They were also assisted by instructional specialists from the Planning Team of the Electronic Academical Village Project to design online projects which reflected specific curricular needs. Training materials were rewritten to be more descriptive and user-friendly.

Conclusions

The use of the Concerns-Based Adoption Model provided the Planning Team of the Electronic Academical Village with an objective and effective tool for assessing how individual participants were using telecommunications with their students and their concerns about doing so. The findings alerted the Planning Team to changes that were needed to increase the effectiveness of training and support and provided insight into the circumstances and experiences that encouraged or inhibited participation. Without the information provided by through the Concerns-Based Adoption Model, the success of the Electronic Academical Village Project would have been greatly diminished.

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Technology Changes Curriculum: Or Does It?

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How will we know when educational technology has made a positive impact on our schools? When technology is used unobtrusively for learning, as determined by the student or teacher, technology will have changed education. The success of technology for delivering and organizing information, and for helping us solve problems, undoubtedly will be measured using new methods of assessment that are still in the developmental stages. To guide us through these years of technological change in education, it is helpful to consider characteristics of the change process that are known to exist across disciplines as innovations shape society.

Change Theory

Toffler (1970) believes technology impacts a society in four stages that are linked in a self-reinforcing cycle: (a) the creative, feasible idea; (b) its practical application; (c) its diffusion through society; and (d) its generation of new, creative ideas. Naisbitt (1982) identified three stages of technology as it spreads through society: (a) new technology follows the line of least resistance; (b) technology is used to improve previous technology; and (c) new directions or uses are discovered that grow out of the technology itself. According to these futurists, when an innovation has made a substantial difference in the environment in which it is used, the change will be continued. Often the innovation brings about new ideas or directions.

Change, as the diffusion of innovations, has been studied extensively in the fields of sociology, anthropology, and communication by Rogers (1982), while educational change has been summarized by Fullan (1991). A model of change based on change theory from both Rogers and Fullan was constructed by this author in a case study of the diffusion of computers within a technology-rich rural school district in eastern Washington state over a ten-year period.

The model consists of three phases of change: adoption, implementation, and continuation. Each phase was analyzed to find examples of how the computer as an innovation at Silverpoint School District has progressed to the continuation phase where the computer has impacted the learning environment. To measure change it was necessary to isolate specific subjects of the curriculum that used the computer for instruction and to follow each through the process of change. Although the study identified four curriculum areas that moved beyond adoption to the implementation phase of change and were institutionalized in the continuation phase (Anderson, 1993), the findings show that most educational uses of computers in the district did not move beyond adoption. This paper will compare characteristics of the adoption, implementation, and continuation phases of change with specific data from Silverpoint School District to illustrate the use of change theory to guide and evaluate technology diffusion efforts.

Methodology

The school district selected for this case study was chosen from among three school districts in eastern Washington identified for their computer-rich environment through a national survey (Beaver, 1989). Silverpoint

School District is a rural/suburban school district with an enrollment of 1900 students in the high school, middle school, and two elementary schools. Pseudonyms are used throughout this paper.

The study gathered information using three tools of case study research: a) the in-depth interview, b) the direct observation, and c) the review of documents from district archives. Descriptive data collected during the interviews were checked against data collected from direct observation and from a review of the records kept by the district from 1982-1992. Thus triangulation was used to validate the findings of the study.

Change theory served as a framework within which to study the process of change using the computer as an innovation. The data were organized in a chronological manner and compared to the theoretical framework of change theory. A timeline was constructed that compared the dates and characteristics of events related to acquiring and teaching with computers to the three phases of the change process.

To analyze the change process pertaining to computer use in the Silverpoint School District, it was necessary to study computer software used by the educators in specific curriculum areas. Early in the analysis it was observed that teachers used software in one of two ways: either they made use of software to teach the knowledge base of a curriculum area, or they used the software as the focus of computer literacy efforts. Further analysis of the data revealed that when the computer was used for instruction within a curriculum area, use of the computer as an innovation moved from the adoption phase to the implementation phase of change. Computer literacy classes piloted new uses of the computer, but the focus of the class did not remain constant enough to move computer literacy classes out of the adoption phase.

Once the data were organized according to the characteristics of the phases of change, it was necessary to determine how long a curriculum program remained in each phase of the change process. Most uses of the computer in curriculum areas did not move into the implementation phase. The four curriculum areas that were implemented had an adoption phase that lasted between two and four years. When the curriculum program used computers for at least two additional years in a way that indicated the curriculum could no longer be taught without computers, it moved from the implementation phase into the continuation phase.

Rogers found that individuals within a social structure become interested in an innovation at different times. Some individuals initiate the change process by quickly adopting the innovation, while others adopt only after the innovation had been successfully implemented by others. Rogers (1982) identified five types of adopters: a) innovators; b) early adopters; c) early majority; d) late majority ; and d) laggards (pp. 248-249). This study identified the innovators at Silverpoint in an attempt to learn the earliest uses of the computer and to trace its diffusion throughout the school district over a ten year period.

Adoption Phase of Change

There are three stages of the adoption phase of change: knowledge, persuasion, and decision. This phase extends from the time a new computer user begins to perceive the advantage of computer use for learning to the forming of an implementation plan prior to beginning the implementation phase of change.

During the knowledge stage of adoption, an adopter's background relative to his or her interest in educational technology indicates their predilection to use the computer. For example, four of the ten innovators interviewed for the study had experienced the profound effects of computers on the business world. Four others had used computers in electronics or other contexts before becoming teachers. Therefore, these innovators had a perceived interest in computers before they used them in the classroom and actively pursued activities that led them to the persuasion stage of adoption. For example, Emery, whose background was in electronics, recalls when he first saw a laser disc used for car repair training in the early 1980s. A repair man touched the computer screen and the picture began to move. Parts of the car were identified and definitions could be requested. The transmission was taken apart on screen and put back together. Review was built in. Emery imagined the use of laserdiscs in history classes. He had prior knowledge of the benefits of computers in other fields and projected its usefulness to education.

During the persuasion stage of adoption, the adopter develops a positive attitude toward the innovation. The innovators at Silverpoint received administrative support to study the educational use of the computers, to begin using computers, to attend computer conferences, and to visit sites where computers were being used. Hans was on the committee that studied the feasibility of purchasing computers beginning in 1980. He recalls that sales people were pushing certain computers, but their committee eventually chose to purchase computers that were supported with educational software. "Districts around us bought computers one or two years before us, but those computers ended up in closets because they were moving in the wrong direction" (Anderson, 1992, p. 16). During this stage the study found a correlation between the district's mission and the belief of the innovators that computers could improve and individualize learning. The mission statement reads, "Above and beyond all else, we never lose sight of the fact that our foremost goal is to maximize opportunities for all Silverpoint students to reach their unique and individual potentials" (p. 58).

The decision stage includes the gathering of hardware and software, training of personnel, the trial of the computer in curriculum content, and the development of an implementation plan. Few curriculum programs at Silverpoint moved out of the adoption phase of change; most remained in the decision stage of adoption, quagmired in the issues surrounding hardware, software, and training.

One example must suffice. Four innovators at these schools identified the writing curriculum as an area that would benefit from using word processors. To use word processing for writing, students need to have both hardware and software readily available during the decision stage of adoption for a fair trial. Teachers at these schools were not able to rely on the computer for writing projects because there were not enough computers or printers available. Therefore, the use of computers for writing at the middle and elementary schools was not given a trial, even though teachers were persuaded computers would aid students in their written work.

Analysis of the data revealed that four curriculum areas moved successfully through the adoption, implementation, and into the continuation phase of the change process with computers: the computer applications class, the technology class, LOGO programming in fourth grade, and decimal curriculum in fourth grade (Anderson, 1993). This article will use the computer applications class in the high school as an example of changes made to curriculum when the computer is used for learning.

Computer literacy classes began in the high school in January, 1983, using four Apple computers gathered in a small, unused room. All teachers were encouraged to teach computer literacy to their students. Therefore, Hans decided to include computer literacy in the shop class he was teaching. Although Hans' classes began by emphasizing programming in BASIC because there was not much software available, he quickly focused on using the computer to manage information and teach problem solving skills. Hans taught AppleWorks with twelve computers in 1984-1985. Once students learned how to use the application software, they began to simulate problem solving activities such as: What does it take to live on the salary of a specific career and pay for rent, food, insurance etc.? Hans and two math teachers collaborated on writing a curriculum package called *Born Naked Without a Job* that simulated lifestyle choices. To begin the simulation, students rolled a die to determine their level of education, from a high school dropout to a university graduate. They researched careers that corresponded to their educational level. Once they had chosen a career, they earned money, learned to manage a checkbook, and received and spent money based on events described in the curriculum package. Hans wanted to engage the students in solving real problems.

By January, 1985, Hans recommended to the computer committee that a class called computer applications focus on problem solving using applications software. The emphasis of the new class was not on teaching about the computer, but rather on using the computer to solve real problems. Thus the computer literacy class changed its name to the computer applications class, and moved to the implementation phase of change because the two-year trial revealed the potential of the computer to teach problem solving skills. By 1985-1986, the computer applications class was offered to all students during their freshman or sophomore years of high school.

Computer hardware and software purchases for Silverpoint School District were guided by a computer committee, but no formal implementation plan was in place during the 1980s. It was the individual efforts of the innovators, rather than policy or a formal implementation plan, that guided the computer applications class into the implementation phase at Silverpoint. Although support was given to innovative computer-using teachers throughout the phases of change, there was no coercive mechanism to involve early or later adopters to use computers.

Current findings suggest that it is crucial to remember that as the use of the computer is passed from an innovator to a later adopter during the implementation phase, the new adopters must go through their own adoption stages (knowledge, persuasion, and decision) even as the innovators move on to the implementation phase. The new adopters gather information about the benefits and drawbacks of the computer in education, persuade themselves concerning the potential of the computer in their classroom, and choose to try the computer. During this time new adopters need ample support for their risk-taking efforts. Both Rogers and Fullan are clear about the need for individuals to make their own commitment to a change effort. Superficial change is a major hindrance to the progress of an innovation beyond implementation to the continuation phase.

Implementation Phase of Change

There are a number of complex variables involved in change during the implementation phase. The move from adoption to implementation usually involves an implementation plan, however sketchy and elastic. Teaching materials, strategies, and management change when computers are used in the curriculum during the implementation phase. Additional hardware and software are in place. The most important characteristic of this phase is the spread of the use of computers to other teachers. The innovators and early adopters of the computer not only use computers in their own classrooms and continue their own self- training, they also help later adopters begin using computers for learning. Each of the characteristics of this phase of change will be treated separately as they were exemplified in the implementation of the computer applications class.

An implementation plan usually sets the parameters of diffusion among new adopters, but Silverpoint had no formal plan in 1985-86 when Hans implemented the computer applications class as a regular part of the high school curriculum. The computer committee based its decision to offer this class on Hans' recommendation. Hans' decisions were guided by an advisory committee of business people from the local community. During the implementation phase the advisory committee suggested Hans purchase MS-DOS computers for the high school. The computer committee agreed to buy the MS-DOS computers because they wanted the students to use different computer environments throughout their years at Silverpoint. By Fall, 1987, there were 12 MS-DOS computers in the high school lab. The Apple computers were moved to the middle and elementary schools.

The computer was first used at Silverpoint School District with no prepackaged curriculum. Innovators made independent decisions regarding the use of computers for curriculum. The study found that innovators went beyond the suggestions of the computer committee as they incorporated the computer into their curriculum. Hans changed the use of the computer from teaching about itself, i.e., teaching programming in a computer literacy class, to teaching problem solving using application software. The teaching strategy used by Hans for the computer applications class was driven by his conviction that the students need to learn something that is real to them. Computers gave him a tool that was powerful and enticing to students. It was used in the real world of business. Hans taught the students to use the software, and then he guided them as they worked on their simulation projects. It was important to him that the students take charge of their own learning. The computer allowed Hans to put his educational philosophy into practice.

Another effort of the implementation phase is towards spreading the innovation throughout many adopters. Teachers were encouraged but not coerced to change at Silverpoint. The computer committee offered suggestions only. During the implementation phase of the computer applications class, one additional teacher, Freda, was trained to use the materials Hans had written. Freda was a business education teacher who began using computers for keyboarding and wordprocessing in 1986. She began teaching computer applications in Fall, 1987. Many other teachers in the district were experimenting with the use of computers for curriculum delivery, but few were using computers at the implementation phase of the change effort.

The computer applications class moved into the continuation phase of change during the 1987-1988 academic year, after an implementation of two years and with a MS-DOS computer lab of twelve computers in place. The class was given administrative support in terms of personnel, policy, and financial assistance to sustain it indefinitely. And the problem-solving curricular focus added new and creative curriculum to the high school offerings.

The Continuation Phase of Change

This study used four characteristics of continuation to determine which curriculum programs advanced to this phase. These four characteristics are often found to be lacking in change efforts that have been discontinued. They are: (a) strong local support must be in evidence; (b) policy which will assure continued support is needed; (c) the innovation must "get imbedded or built into [the organization];" and (d) the innovation generates another innovation (Fullan, p. 89). In the computer applications class, the computer lost its uniqueness in terms of being a focus of curriculum. The focus of learning was on applying software to solve problems rather than on learning how to use a computer for its own sake.

Local support has been especially strong for the high school programs at Silverpoint. The educational philosophy of the district to train students for the workplace has focused district efforts on the students who are soon to graduate. Another indication of administrative support is staff stability, which enhances the chances of an innovation becoming continued. The most recent innovators in the district arrived in 1986.

District support in terms of new hires is further evidence that administrators intend to continue funding and maintaining district computers. Teacher/innovators like Hans were relieved of total responsibility for maintaining district computers in 1986 when a full-time technician was hired to care for the new phone system as well as computers. In addition, a classified person was hired to manage the computer labs in the elementary and middle schools in Fall, 1991. The computer committee recommended that a full-time district computer coordinator be hired next.

The computer committee makes the policies regarding computer use in the district. The assistant superintendent is concerned that more policies be set for the district so that the computer program is not dependent on individual people. Two high school classes have been supported into the continuation phase of change by policies of the computer committee. However, additional policies regarding equitable diffusion of the computer are needed in the district, especially for the middle and elementary schools.

Both Rogers and Fullan believe that continuation happens when an innovation is imbedded within the institution. Toffler and Naisbitt believe that technological innovations generate new, creative ideas. In this study the computer was found to be imbedded in problem solving curriculum. The computer applications class became an innovative addition to the high school program. Change theory identified educational uses of technology that changed curriculum over time.

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Evaluation of a Program Introducing MIDI Keyboards into Five Schools

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This discussion highlights steps in the evaluation of a program to integrate MIDI piano keyboards into the regular music instruction at elementary schools. One goal of the keyboard program was to encourage the use of cross-curricular skills. The evaluation was conducted to assess the appropriateness of the initiative began after the keyboards were installed at two sites.

The Assessment Process

Purpose

We evaluated the appropriateness of the initiative by focusing on educational variables represented by memory skills and sentiment towards school since these variables represented areas that were fundamental to learning and were therefore relevant for cross-curricular education and because of the likelihood that keyboard instruction could contribute to their development.

Instruments

Two scales were used: the Wide Range Assessment of Memory and Learning (WRAML) (Sheslow & Adams, 1990) and the School Sentiment Inventory (SSI) which we developed for this project. The first scale assessed visual. learning; verbal learning, sound-to-symbol recall, and sentence memory. The second scale assessed for sentiment towards school overall, music class, the keyboard and other regular school subjects and activities. The goal was to compare preference of sentiment of keyboard music instruction to the other factors. A psychometrician, the third author, administered the assessments and trained assessors to administer assessments.

Participants

Pupils in early elementary grade at five schools were evaluated. The pupils and the schools differed demographically. School 1 was in a poor urban center. All the pupils were black. School 2 was in a different poor urban center. The group of pupils was nearly evenly split racially between black and white. The third school was in a middle-class suburb. Nearly all of the pupils were white. The fourth and fifth schools were in the same large semi-rural school district. All of the children were black.

The pupils at all of the schools underwent music instruction as part of their regular curricula. The music instruction at the first three schools also included keyboards. Because the fourth and fifth schools were in the same school district and the pupils were instructed by the same teacher, it was possible to contrast the pupils at both schools — one school used the keyboard, the other did not.

Pupils at all of the schools used the electronic keyboards in pairs. The keyboards were equipped with headphones so that during instruction the pupils would monitor their own playing without being disturbed by others' playing. The teacher could supervise all of the pupils and could hear any of the pupils selectively via the teachers' keyboard equipped with a computer control panel.

Procedures

The WRAML and the SSI were individually administered to all of the pupils from the five schools. There were

174 pupils in the comparison groups and 91 from the other three schools. The project occurred as an ongoing program in the settings of the schools. The schools' calendars were typical with the beginning of classes in either early September or late August. Assessors were trained and the first assessments were begun in October and completed in February. This long assessment period was due to the scheduling of the assessors and children since each child was assessed individually. The experience gained during the first round of assessments resulted in the second round of assessments being completed during a 30-day period in March and April. The assessments were tabulated and hand-scored under the supervision of the psychometrician.

Results

WRAML Findings

The two schools in the comparison group scored about the same on the two assessments and they both improved from the first to second assessment. Similarly, the results between the first and second assessments for the non-comparison groups were not appreciably different. That is, there were no discernible gains in memory skills for any of the pupils that could be clearly attributable to keyboard instruction.

School Sentiment Findings

Schools with Keyboards Compared to Schools without Keyboards. There were eight items of a general nature the majority of which focused on sentiment toward music to which pupils responded by selecting one of seven faces depicting sad to happy. The responses were scored from 1 for sad to 7 for happy. The pupils from the schools that were compared as to having the keyboard and not having the keyboard responded very favorably to the music questions for the second assessment. The keyboard group responded slightly more favorably than the no-keyboard group on all eight items.

A multivariate analysis of variance (MANOVA) was used to test for differences between the two groups on the eight questions ($F(8,165) = 1.562$, $p = .14$). Also, univariate t tests indicated that both groups of pupils responded quite favorably to the music questions. Significantly, the keyboard group responded slightly more favorably than the no-keyboard group on all eight questions. This may be a positive indication of a keyboard effect.

The eight items were also totaled to produce a subscale score for each child representing the eight items. Analysis of covariance (ANCOVA) which used the first assessment subscale score as the covariate was statistically significant in favor of the keyboard group ($F(1,171) = 7.64$, $p = .006$). The ANCOVA was followed with an effect size analysis between the two adjusted means. The effect size was .33 which supported the MANOVA and univariate ANOVAs suggesting a small but favorable keyboard effect.

The percentages of pupils who selected the keyboard or a musical instrument as their first choice favored the keyboard school on both the first and second assessments. Both schools decreased their preference by the time of the second assessment. However, they were competing with a powerful other choice—the computer. The 36% selection for first choice on the first assessment by the keyboard school is very promising. The fact that it decreased to 22% by the second assessment probably reflects that the novelty had worn off. The 22% is still considered good when considered in competition with the computer which may be perceived more as a video "toy" by children of very young ages and may prolong a novelty effect. Also, the keyboard school demonstrated a higher preference for the keyboard than did the no-keyboard school. A low percentage of children in both groups chose story books.

About 10% more of the keyboard school selected their music class as their preference among the three comparisons than did the no-keyboard school. Another way to consider the preference for music is to look at the differences between the first and second assessment for the two schools. Keeping in mind that the first assessment was conducted, for the most part, well after the keyboard was introduced, it can be seen that music class fared particularly well for the keyboard group, especially when compared to spelling and reading. Had the first assessment been conducted prior to the introduction of the keyboard, it is likely that the percent increases for the keyboard school would have been greater.

Another approach was employed to elicit the children's sentiment toward music as well as a number of other classes and activities. The child was presented with nine illustrations each of which was accompanied by a sketch of a face without a mouth. The child responded by drawing a mouth associated with the illustration. The mouth was "scored" as positive, negative or neutral. The nine illustrations represented reading, PE (physical education), lunch, numbers, music, recess, art, writing, and spelling. Comparisons were made between the keyboard and no-keyboard schools on the nine illustrations for the second assessment. The only difference was on the music illustration where the keyboard group had over 12% more positive faces than did the no-keyboard school.

The last measure taken in regard to music was to ask the children to name their favorite class. This question was asked at the termination of the second assessment. Seventeen percent of the keyboard school reported music as their favorite class while only seven percent of the no-keyboard school named music. This difference was statistically significant.

Overall, the school sentiment data favorably support the keyboard school. The data gathered for the first three schools that were not contrasted with the absence of the keyboard, also showed a preference for the keyboard and music when compared to the items about their other school subjects such as computer use, reading, letters and PE.

Discussion

We consider the School Sentiment Inventory results very encouraging regarding the integration of piano keyboards into an elementary school curriculum. We surmise that the pupils' achieving competence in keyboard instruction contributed to their approval ratings of school and music instruction. The sentiment underlying the ratings may develop a value for keyboard instruction that may transfer to other learning or school work.

The lack of differences in terms of affecting memory skills can perhaps be explained by the fact that the pupils underwent about thirty minutes of music instruction per week that is with or without keyboard. It is unlikely that this was enough time to develop the memory skills emphasized in music performance instruction. At the same time, the favorable sentiment towards music and school can be attributed to this short amount of instructional time.

Practical considerations

There were several observations made which we would like to share. First of all, the point of the study was to evaluate the appropriateness of the introduction of an innovation. For this purpose a large sampling of participants was made. Therein were many of the logistical obstacles. The sites were in three different states and even within states, the sites were far apart. Travel to and among the locations was sometimes hampered by those factors that normally affect travel—weather, cost, time, etc.

The orchestration of personnel, specifically the assessors, required the identification of dependable and capable local personnel. These were found among college students and teachers. Communication was essential and was most prized when it was absent but needed or misinterpreted. There were logistics that seemed to be beyond control, for example, the initial delays in assessment.

We consider these obstacles normal in program evaluation and hope that future evaluations will have fewer, but fully expect that any that we eliminate will be replaced by others not anticipated. Indeed, we also consider the evaluation successfully executed and believe we have learned about the appropriateness of integrating MIDI keyboards into elementary school curricula. Based on the results of the SSI, it appears that the keyboard could be used as an important vehicle to build students' values—to learn to enjoy schoolwork.

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Making Barriers Explicit: Some Problems with the Computer Innovation Literature

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This paper highlights some difficulties with interpreting the literature dealing with the implementation of computers in schools which need to be addressed if future research is to be more effective in predicting how to turn a vision of learning enhanced by computer use into a reality. It goes on to suggest an approach which might help to overcome some of the problems identified.

The strong belief that using computers can enhance children's learning permeates much of the literature (see for example Brown & Howlett, 1994; DES, 1989; NCET, 1993; Niemiec & Walburg, 1992; Watson, 1993b). However in order to devise training which will enable teachers to capitalize on that potential teacher educators need to be aware of the factors which promote or inhibit effective computer use within an educational context. A good deal of research has focused on the implementation of computer use in schools in order to identify barriers to their use (see Grunberg & Summers, 1992 for a review), presumably with the intention of enhancing computers' educational impact. In spite of this research there is a substantial amount of evidence which suggests that schools still make little use of computers and that even where they are used the quality of use is generally low (Bell, 1993; Plomp, Pelgrum, & Steerneman, 1990; Rhodes & Cox, 1990; Watson, 1993a). The issue of the quality of use is crucial: Maddux (1993) has pointed out that computer use, per se, is no guarantee of educational enhancement.

Difficulties With Interpreting the Literature

Definitions of Computer Use

There is much confusion in the literature about what constitutes "computer use". This ranges from talking about computers with students (Anderson, Hansen, Johnson, & Klassen, 1979), through using a computer once per term (Zammit, 1992), to integrating computers across the curriculum (Blease & Cohen, 1990). If the research findings are to be generalizable it is vital that definitions of key terms, such as "computer use" are clearly and explicitly stated. Otherwise the danger exists for misinterpretation and confusion.

This problem is compounded by the fact that there are many different possible perceptions of what "effective use" of computers means. One's definition of effective use is particularly important in the light of Maddux's (1993) comments on computer use mentioned earlier. One's definition of effective use will vary considerably depending on such factors as one's pedagogical stance and beliefs about how children learn. Willis & Robinson (1994) provide a convincing example of this when they describe the different perceptions of two hypothetical teachers towards two hypothetical pieces of educational software: The first teacher, who is "a strong traditional educator", is identified as seeing an Integrated Learning System (ILS) as an effective tool. The second teacher, who "believes strongly that reading is a social activity of the whole child" (p. 4), is identified as seeing an integrated word processing, desk top publishing, painting, drawing, email and information handling package as being an effective tool. Each teacher has major problems with the other software package because it does not fit in with their respective theories of teaching and learning.

Taking this further it has been suggested that "teachers from different subject areas are likely to have different perceptions of the use of computers in learning, as the knowledge, aims and skills associated with different subjects vary quite widely" (Squires, 1994, p. 6).

Thus problems with definitions of computer use are compounded by one's subject area, pedagogy, and educational philosophy. Pedagogy and educational philosophy are likely to vary depending on the culture in which one is operating which is in turn likely to be linked to the phase of education and geographical location. It would seem reasonable to suppose that there would thus be significant differences between the definitions of "effective computer use" between countries where there are cultural differences in educational philosophy, organization, and aims: What is effective computer use in the USA may not be considered effective in England. Thus particular care needs to be taken when generalizing from studies undertaken in different cultures to one's own.

Resource Issues

Just as with definitions of computer use it is important to be clear about levels, quality and organization of resources when trying to make sense of the "barriers literature". To give an extreme example, it would be inappropriate to generalize from a situation where two classes had to share one eight bit computer with one in which a class had sole use of an up to date and fully equipped computer room with technical support for several hours per week.

It is possible to identify factors which affect the level, quality and organization of resources, for example early research in this area is likely to be dealing with smaller numbers of less powerful machines than more recent studies.

The phase of education may influence the resources. Within England there are significant differences in the quality and quantity of computer resources in primary and secondary schools according to the latest government statistics (DE, 1993). In addition the access arrangements vary between primary and secondary schools: primary schools tend to distribute their computer equipment throughout the teaching rooms, typically one stand alone machine per class, whilst secondary schools tend to concentrate the computer resources in a small number of networked computer rooms.

Geographical location also plays a part in determining computer resources. For example within the UK the education authority in each region identified which computer system(s) they would support and different authorities adopted different systems. Schools were often only able to acquire the approved models. Thus primary schools in the Inner London area tend to use machines made by Research Machines (DOS & Windows) and those in Gloucestershire use machines made by Acorn (RISC OS).

When dealing with resource issues there is also much scope for misinterpretation. This is compounded by the fact that perceptions of what constitutes high quality in terms of resources may change over time. In the early 1980's an eight bit machine with a floppy disk drive and color monitor would have been considered state of the art. Today we would consider the same equipment to be at best under powered and perhaps even obsolete.

Phase issues

Grunberg (1992), discussing the generalizability of relevant research findings from different phases, argues that the "issues at each level are often closely related" (p. 261). However there is little evidence to suggest that this is true. In addition to the differences in the allocation of resources between the different phases already mentioned above the managerial structure within a primary school is different to that in a secondary school or higher education institution. Primary schools tend to have much flatter organizational structures than secondary schools, at least in part due to their smaller size. In addition, it has been suggested that small schools have a stronger sense of purpose and are more inclined to adopt innovations (Anderson, Hansen, Johnson & Klassen, 1979). This would lead one to suspect that different, though perhaps related, factors will affect computer innovation and use in each phase. Thus caution needs to be exercised when making generalizations on the basis of research which focused on phases of education other than those with which you are concerned.

Innovation cycle issues

In order to make sense of the "barriers literature" one needs to be aware of the stage in the innovation process that is being dealt with. Heppell (1993) has suggested four stages of evolution of educational computing, each with its own characteristics. To extrapolate from one stage to another might be inappropriate if the underlying assumptions and aims at each stage are different.

To add to this it has been suggested that "the spread of educational innovation tends to follow the normal curve" (Watson, 1991, p. 546) with a small number of "early innovators" being followed by larger numbers of "innovation followers", then "innovation reluctants" and finally a small number of "non innovators".

To claim that the factors affecting the uptake of computers by innovators are the same as those affecting innovation followers or reluctants would seem misguided. However, if the literature does not explicitly state what stage in the innovation process is being dealt with or which group of teachers is the subject of the study then such a misguided claim is likely to occur.

Predictability issues

If one accepts that the aim of any research in this area is to provide evidence which will help to improve the uptake of "effective computer use", irrespective of the definition you adopt, then the outcomes of that research need to have some predictive power. Thus whatever methodologies are being used the research must be valid and reliable and must produce outcomes which can inform future action.

Most of the research into computer innovation in education has provided what Richmond & Peterson (1992) refer to as "laundry list models": a range of factors are identified (See for example Rhodes and Cox, 1990) but the relative importance of each of the factors that are identified and how they interrelate are unclear. What is needed are models which not only identify what the barriers are but also give an indication of the relative importance of each of the factors, how they produce their effects and how the factors and their interactions change over time. What is needed are explicit and dynamic models.

Explicit, Dynamic Models

By their very nature explicit, dynamic models cannot be clearly represented in a static paper form. However Figure 1 and the accompanying assumptions/equations describe a very simple example of such a model.

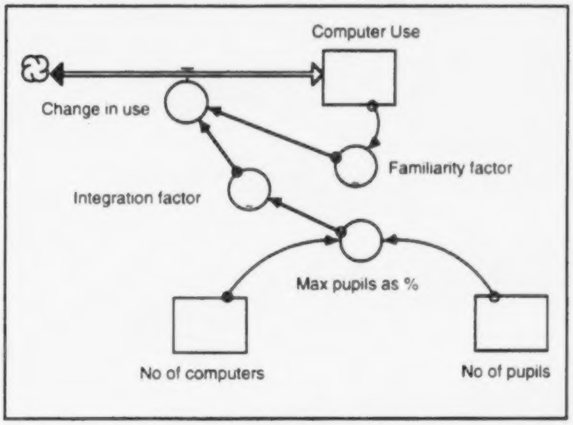

Figure 1. A pictorial representation of an extremely simple example of an explicit, dynamic model.

This model encapsulates the following assumptions:

1. Three children can share one computer.
Maximum pupils as % = (No of computers*3/No of pupils)*100
2. The larger the percentage of the class who can use a computer simultaneously the easier it is to integrate computer use into classroom practice. This is represented by a graphical expression in the model.
3. The more you use a computer the easier it becomes. This is represented by a graphical expression in the model.
4. The easier it becomes to use a computer and to integrate it into the classroom the more it will be used. Change in use = Familiarity factor+(Integration factor/10)

Figures 2 and 3 show how the variables alter over time with different starting conditions. In each case the initial value for "Computer Use" is 30 minutes per day and for "Pupils" is 30.

The graph in Figure 2 shows that the model predicts that with a class size of 30 and only one computer (Line 1) the level of computer use will drop (Line 5). This drop in use is caused by the difficulties of integrating one computer into the class (Line 2). Lines 3 shows the rate of decline in computer use. A reduction in use leads to a reduction in familiarity (Line 4).

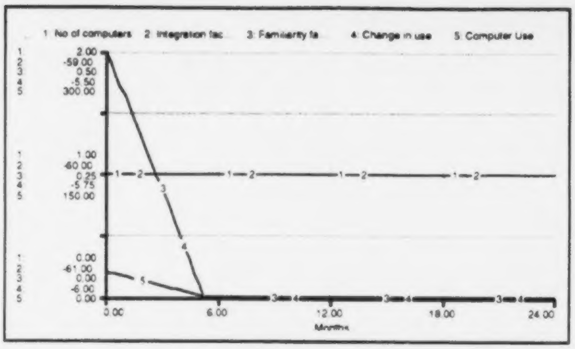

Figure 2. Graph showing change in variables over time with one computer.

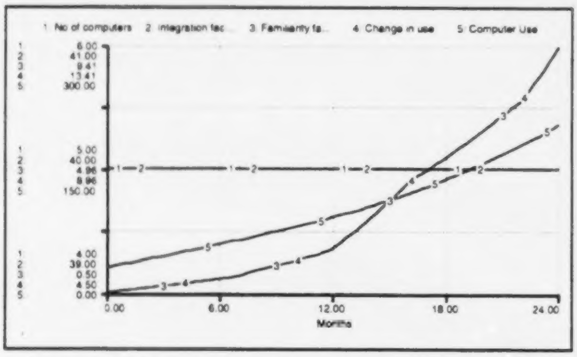

Figure 3. Graph showing change in variables over time with five computers.

The graph in Figure 3 shows that the model predicts that with a class size of 30 and five computers (Line 1) the level of computer use will rise quite rapidly (Line 5). This increase in use is caused initially by the increased ease of integration when five computers are available (Line 2). Lines 3 shows the rate of increase in computer use. An increase in use leads to an increase in familiarity (Line 4) which in turn leads to even greater use. Hence line 3 shows an accelerating rate of change of use.

Advantages & disadvantages of explicit, dynamic models

An explicit, dynamic model has three significant advantages over the "laundry list" type of model:

1. Wood (1994) claims "It is better to be wrong than to be vague" because if you are wrong you can alter and improve your explanations. An explicit, dynamic model cannot be vague and "the computer's ability to 'execute' a model leads to the possibility of evaluating that model" (Millwood, 1993 p2) and hence improving it.

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2. The process of creating such a model requires clear thinking about the factors and relationships. "The computer's demand for formality in expression forces the modeler to discover more precisely what their knowledge is", it reveals implicit assumptions which might otherwise go unchallenged. Just as metacognition in the context of LOGO programming enhances conceptualization of problems, so does building explicit, dynamic models. In both cases the process of thinking about your thinking helps to improve your mental schema.
3. While explicit, dynamic models inevitably require the quantification of variables the process of building such a model can incorporate both qualitative and quantitative data. This may be another way to overcome problems of generalizability of qualitative data. Much as meta-analysis allows the combination of statistical data from different studies, building explicit, dynamic models allows both quantitative and qualitative data from different studies to be integrated. For example within the model presented here the "Integration factor" does not represent a measurable quantity but quantifies beliefs about the impact of different proportions of the class being able to use computers simultaneously.

However explicit, dynamic models also have significant drawbacks not least of which is the incredible complexity of the factors involved in computer use in schools. Developing an explicit, dynamic model which reliably reflects reality would appear to be an extremely challenging task: the best we can do is provide simplified models which help us understand the issues more clearly.

Conclusions

Great care needs to be taken when generalizing from past research into the adoption and assimilation of computers in schools. Many of the problems relate to differing circumstances within the studies and the situations to which they are being compared. Other problems relate to the type of models which are being used to describe the innovation process. It is suggested that by adopting an approach which utilizes explicit, dynamic models some of these problems can be overcome. This in turn should lead to research in this area having greater impact on educational practice in the future. "By thinking in terms of how a system really works (i.e. its "physics"), we have a much better chance of understanding how to make it work better!" (Richmond & Peterson, 1992, p. 30).

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Telecommunications: A "Hook" to Facilitate the Infusion of Technology Throughout Teacher Education Programs

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Although there is general agreement that computer-related technology needs to be integrated throughout teacher education Curricula (Byrum & Cashman, 1993), a review of the literature shows that most teacher educators do not use computer technology in their classrooms (Wetzel, 1993) Currently educators working to infuse technology throughout teacher education programs, and to motivate teacher education faculty to acquire expertise in this area are facing many challenges. Some of these challenges include teacher educators' lack of time or inclination to commit to full time technology courses (Brunner, 1992) and the slow pace with which teacher education faculty are acquiring expertise in using technology in their instruction.

In its three phase program designed to infuse technology throughout a teacher education program, the Department of Curriculum and Instruction at Iowa State University has found that beginning telecommunications activities provide a simple and useful introduction to using computer-related technologies. Beginning telecommunications skills are relatively simple for faculty to acquire and are almost immediately applicable to needs to tie teacher education students more directly to both K-12 classrooms and educational research.

This paper, after reviewing the literature related with the educational benefits of telecommunications, will describe the evolution of use of telecommunications in the teacher education program. It will then discuss the impact of using telecommunication for instruction in the program. Finally the paper will provide descriptive data on the faculty's reactions to telecommunications capabilities.

Literature Review

Benefits from the Use of Telecommunications

Providing educators with access to telecommunication technologies is a priority that is currently receiving much attention in educational reform agendas. The use of telecommunications is creating new educational opportunities for professional development and instructional purposes not previously possible.

The literature has documented several benefits related with the use of telecommunications. One of the most important benefits is that educators can have access to a wealth of information, ranging from reports on educational research, to curriculum guides and lesson plans (Honey & Henriquez, 1993). The use of large databases, networks, and bulletin boards empowers teachers to break their professional isolation. As Hawkins reported (1993), telecommunications give teachers the tools to develop and sustain conversations with experts and peers and to exchange and discuss well-developed materials and examples of good practice (Hawkins, 1993).

In addition, Honey and Henriquez (1993) in as recent national study found that for most teachers that participated in the study, the integration of telecommunications into their teaching made a real difference in how they teach. They specifically found that the use of telecommunications enables teachers to spend more time with individual students and less time lecturing to the whole class.

The literature has also showed evidence that students in a variety of educational levels and settings benefit from the use of telecommunications. Students are able to gain experience in gathering and analyzing scientific data, carrying out creative writing projects, and exchanging information with people from around the world (Honey & Henriquez, 1993). Solomon (1989) found that cross-cultural understanding is promoted when students telecommunicate with students from other countries.

Moreover, Tamashiro and Hoagland (1987) reported several benefits to students of using an electronic bulletin board and posting a story for other students to add to: risk-free self expression, more attention to story content, increased interpersonal respect, cross-age communication, and feelings of self worth. Finally, a benefit reported by Slovacek and Doyle-Nichols (1991), is that telecommunications improve effective communication between students and instructors because electronic mail is more convenient and appears to be less intimidating.

Telecommunication Uses in Teacher Education

telecommunication technologies in a variety of forms, such as electronic mail, computer bulletin boards, and distance education, are becoming increasingly available in teacher education programs. The need to prepare teachers that will be knowledgeable in the use of technology, but also the potential of telecommunication technologies to enhance the teacher preparation program, led many teacher education institutions into incorporating telecommunication into their programs.

The literature provides many examples of teacher education institutions that have developed telecommunication projects as part of their teacher preparation programs. Schrum (1991), reported an example of an electronic network developed by the Harvard School of Education that helped beginning teachers get help and support from faculty and other first year teachers. Another example is an electronic bulletin board system developed by the Curry School of Education at the University of Virginia that connects student teachers in the field with their university professors (Schrum, 1991). Students are given an electronic mail account and are able to communicate with professors, colleagues, and classroom teachers.

Discussing the benefits from telecommunication uses in teacher education, Bishop-Clark and Huston (1993) stated that "in teacher education courses, students have the unique opportunity of first benefiting from the technology as a student and then later in their career as a teacher" (p. 252). In the same way professors when using telecommunications enhance their instruction but also provide a model of technology integration. Subsequently this modeling of telecommunication use by faculty will be beneficial for preservice teachers since research suggests that students who experience the use of technology during their preparation programs feel more prepared to use technology in their own classrooms than their peers who do not have similar experiences (Handler, 1993).

Methodology:

During the 1992-93 academic year, the Department of Curriculum and Instruction began a three year program designed to facilitate the infusion of technology throughout the curriculum in teacher education. During the second year of the program, faculty computers were networked using a Local Area Network (LAN) and all faculty were provided instruction on how to use the network. Within two months of establishing the network, department business began to be conducted over the LAN. During the second and third years of the program, all faculty were connected to the Internet and provided access to a two-way audio and two-way video distance education classroom that is connected to 99 schools or area education agencies in the state of Iowa.

Given these telecommunication capabilities, data were collected on the following:

1. Faculty use of the LAN
2. Faculty use of the Internet
3. Faculty use of the distance education classroom
4. Faculty attitudes toward telecommunication in teacher education

Data were collected during the 1994-95 academic year using faculty questionnaires and interviews. In addition, online data on the use of the LAN were collected.

Preliminary Results

Although data collection and analysis are not complete, preliminary results indicate that faculty are very positive about the use of the LAN and find it an efficient way to communicate with each other and with the department head. In a department with 35 full time faculty, the department head receives and answers approximately 10 messages form faculty each day. All faculty who have access to the LAN have used it for internal communication.

Preliminary data also reveal that faculty are using the Internet in a variety of ways to connect their students to K-12 students and teachers and to useful resources. Projects include using the Internet to communicate with the instructor in a multicultural education class, using the Internet and the distance education classroom to allow reading students to communicate with middle school reading students and their teachers, using the Internet to connect elementary education students with K-6 students, using the distance education classroom to connect field experience students with parents of students with whom they will be working, and using the Internet to connect teacher education students with other professional educators.

During the 1993-94 academic year, several faculty who had not made use of their office computers became interested in both LAN and Internet use and through these uses became active computer users. It is interesting to note that for these faculty members, the power and ease of telecommunication use seemed to break the barrier of becoming active computer users. Similarly, almost all faculty attitudes toward the use and potential of telecommunications capabilities are positive, and faculty are especially appreciative of the opportunity to communicate with professionals in the field more easily.

Many faculty are using telecommunications to facilitate communication with students in their classes. Although data are preliminary, it appears that faculty believe that computer communication opens up new avenues for interaction with students. Several faculty report that students seem to be more open and more communicative on e-mail systems than in other modes of communications. One multicultural education faculty member reported that her student course evaluation ratings increased significantly the semester she began using regular e-mail communication with her students. She attributed the increase to the fact that students using e-mail could honestly communicate with her when course material began to challenge their values and beliefs and that she could respond to these concerns in a timely manner. Her experience is now causing other teachers of the multicultural education course to use e-mail in a similar manner.

Summary and Implications

Our preliminary results indicate that telecommunications capabilities provide a useful "hook" to get teacher educators involved with computer-related technologies. Telecommunications capabilities are easy for beginners to use and have very natural applications for instruction in teacher education. Preliminary data suggest that many of the trends found in K-12 use of telecommunications may also exist in teacher education use of telecommunications. More research and development work needs to occur in this very important area.

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Cooperative Learning With Hypermedia

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Over the last decade of educational reform, numerous innovations have emerged which promise to increase student understanding and achievement: mastery learning and teaching, the use of higher level and creative/critical thinking, cooperative learning, learning styles. The areas of mathematics and science have recommended more use of manipulatives, hands-on experiences, interdisciplinary learning, and the use of technology to increase learning. The implementation of many of these innovations has been minimal (Guskey, 1990), sporadic, and often fragmented. Many teachers have considered these innovations and the use of support materials and equipment to be "fads." However, the use of technology in cooperative learning classrooms seems to have had a synergistic effect. Computer literacy teachers have found cooperative learning to be an effective instructional strategy to utilize with the diverse knowledge backgrounds of students in their classes. Content area teachers have begun to integrate the content areas using cooperative learning groups and technology as the medium for organization, research, and presentations.

A marriage between cooperative learning and technology is natural. Cooperative learning refers to selected instructional strategies in which small heterogeneous groups of students work together to master the content and skills in a structured classroom situation. The teacher provides the initial instruction, checks for understanding, then provides an opportunity for guided practice using learning teams. The students in the learning teams have an opportunity to plan and discuss the content and skills of the day. In order for students to be successful in organizing and eventually presenting the content, technology can be used. While the teaching can provide the content, cooperative learning can provide the structure, and technology the medium. Fortunately, both of these are also highly motivational.

Hypermedia is a powerful form of instructional technology that integrates text, audio, graphics, and video with media authoring capabilities. This new player in the classroom has revolutionized educational computer use and has been adapted to a remarkable number of uses in its short history. Frequently the terms hypermedia and multimedia are used interchangeably to describe a linked, nonlinear knowledge structure with multiple data types - text, graphics, sound, animation, video.

Reaction to this new education vehicle has been enthusiastic with *LinkWay*, *Toolbook*, and *HyperCard* being the clear software choices. These easy-to-use multimedia development software tools provide the user with the graphical drawing tools for creating presentation objects and an object-oriented programming language. Simple tools enable novice users to design impressive layouts that merge text and graphics. Information is organized on individual pages residing in "folders", "books", or "stacks". These "hyper" programs offer excellent tutorials, examples, and easy-to-follow documentation. The tutorial feature is especially important to those students without a strong programming background as it enables them to become comfortable with the technology at their own pace. Hardware add-ons which enhance hypermedia use include CD-

ROM, laserdisk, scanner, and video/audio capture capability.

Examples of successful local projects in different content areas, designed in teacher education courses in partnership with laboratory and area schools include:

Social Studies: State Studies—Where In Louisiana and Local Government

Science: Field Trip to the Aquarium of the Americas and Solar System

Mathematics: Pre-Algebra Word Problems and Exercises in Geometry

Language Arts: Hamlet and Poe's "The Raven"

The logical sequence of producing a hyper project requires planning and research before organizing the information in the program environment. Each team sits down together and discusses not only the long-range project, but also each person's responsibility in the project. Each development package provides a tutorial and sufficient examples for the students to initiate project development. However, as the project proceeds, teams reassemble from time to time to make sure everyone understands the total process and each person's responsibility. The choice of software and the level of technology used varies from simple presentations to professional looking products. This open-ended approach to the project development allows each team flexibility to develop applications unique to their interests.

The initial phase in the development process includes project research, media selection and proposal. Each team member must agree with the major parts of the project. They discuss and refine the proposal and eventually submit the proposal to the instructor. After instructor approval, the team determines the structure, format, and project scripting. With a central plan of action, the responsibility for each of these is delegated to individual or pairs of students. Teams can include any system of organization that meets the needs of the activity. As each page is created, flow charts, time lines, story boards, etc. help to keep the project on track.

Multimedia project programs, done in cooperative learning teams, has many outcomes:

1. development of multimedia literacy skills
2. introduction and implementation of object-oriented programming
3. increased use of computer graphics and design
4. incorporation and cooperation in the use of management skills through cooperative planning, design, and research
5. development of social and leadership skills within the cooperative learning teams which includes students with diverse interests and education backgrounds
6. increased levels of creativity and critical thinking

The wonders of hypermedia technology in a cooperative learning environment combines knowledge and instruction with an innovative delivery system. The use of cooperative learning groups in a technological environment has both cognitive and social ramifications. It increases the active involvement of students, promotes higher levels of thinking, and encourages the development of more comprehensive projects. It provides a vehicle for the formation of organizational and leadership skills and the recognition of the value of cooperation among students. The use of technology in a cooperative learning environment reinforces the future role of technology - not as the end product, but as a means to actualize their function as productive members of the 21st century.

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SPECIAL POPULATIONS

Information Technology & Teachers of Special Populations

In the late 40s my (DW) father was in a wheelchair. We lived in a sizable city in the southwest, but there were few business locations with ramps—only two restaurants that had wheelchair access, and one of those wasn't 'planned' — it just had a patio that was at street level. I will never forget my father's frustration. While there are still many things that need to be done, more and more people today are conscious of the needs of others. Certainly, it is an issue of major concern in education.

Even before computers gained a foothold in the regular classroom, technology was being used to create a 'more level playing field' for many people. In the first article of this section Pracek, Director of the Florida Diagnostic and Learning Resources Services, and Baumbach, Director of the Instructional Technology Resource Center at the University of Central Florida, describe the development and use of a laserdisc designed to help preservice and inservice teachers plan learning experiences responsive to a wide range of needs. They also recount some of the lessons learned in designing and putting together this tool for teacher educators.

In the next article McPherson, Coordinator for a Masters program partnership between Johns Hopkins University and the Maryland State Department of Education, describes the Technology for Educators master's program which includes courses on assistive technology for access, mobility, and communication as well as performance assessment. Their three goals are ones we might all adopt and promote.

Bednar, interim Dean of the School of Continuing Studies and Sweeder, Director of Secondary Education, both of La Salle University, were faced with students' high anxiety levels in two intensive courses—*The Teacher and Technological Advances* and *Developing and Adjusting Instruction for Moderately and Severely Handicapped Learners*. To meet their students needs they developed several three-minute videos. These were used in various ways in the two courses, but in both they helped students develop a Gestalt of the goals of the course.

In her article, Dailey, at Towson State University, summarizes the literature on ADHD, recommends the use of computers to meet the needs of students with these conditions, and suggests modifications of teacher education programs to address these issues.

The final paper in this section reports a research study by Kline and Anderson of Wichita State University about their course, *Introduction to Exceptional Children*. They examined the use of a conventional study guide versus a computer-delivered one.

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Learning, Technology, and Special Needs: A Videodisc Sampler

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MORE INFO
ON CD-ROM

The world is changing so rapidly it is difficult to imagine what skills students will need to be successful in the 21st century. Futurists predict that average adults will have seven different occupations during their working lives. Those occupations will all involve technology in some way. This means that education will not end with graduation, but will continue throughout one's adult working life. To be successful in this kind of world adults will need to know how to learn, how to use the tools of technology to help them find information, and how to communicate what they have learned. They will need to know how to use the tools of technology related to jobs which do not even exist now.

This paper will describe the conceptual framework behind the development of the laserdisc, and describe scenarios for possible uses with preservice and inservice educators: 1) raising expectations for access, 2) encouraging educators to plan for acquisition, and 3) showing that almost any technology can provide a meaningful learning experience if it is used appropriately within a good instructional environment. Also discussed will be lessons learned in the development of the product and in implementing the use of the program with educators.

It is a real challenge for educators to prepare their students for such a future. We know that schools as we have known them in the past must change to meet this challenge. Restructuring provides a framework for the changes which must occur in the system to support ways of teaching which will produce students who will become independent, lifelong learners. We know if they are to continue to learn, students need to be excited about what they are learning now, and what they are learning needs to make sense to them now.

Most educators do understand the need for change and the need to involve technology as a part of that change. The challenge remains how to do that effectively. In Software Publishers Association's (1993) "Report on the Effectiveness of Technology in Schools, 1990-1992" student achievement is related to a number of factors. One of these key factors is the role of the teacher. Research suggests that one can maximize the benefits of technology by extensive training of teachers in the integration of technology with the curriculum. Other factors include: providing opportunities for students to engage in self-directed learning experiences, and designing activities which involve tool software, encourage self-expression and stimulate personal interaction among students. In their recommendations for American Educational Decision Makers in Vision: TEST (Technologically Enriched Schools of Tomorrow) (Braun, Moursund, & Zinn, 1993), project personnel reported from their literature surveys that students improve problem-solving skills, develop higher order thinking skills, outscore classmates, and learn more rapidly in a variety of subject areas when using technology as compared to conventional methods. In many cases, students' self esteem was increased when they used computers, as was time on task. In addition, with technology, "students with handicaps are now able to participate in the same kinds of experiences available to other children and are able to achieve their intellectual potential (p. 8)."

Based on such findings, and considering the body of recent research related to learning, schools today need to offer instructional settings which support active and meaningful learning for all students, including those with special needs. Technology must be an integral part of those settings.

Effective Instructional Settings

To create effective learning environments, teachers must integrate technology with successful instructional strategies. Some key elements of good learning environments include active learning, cooperative learning, integrated curriculum, and individualized instruction. In active learning students become involved in the learning process and take responsibility for what they learn. They build their knowledge from the world around them instead of just memorizing facts and procedures. Recent research at Vanderbilt's Learning and Technology Center (The Cognition and Technology Group at Vanderbilt, 1991) has shown that when students are encouraged to generate plans and questions, their gains are much more significant than when more traditional, passive forms of instruction are used. In active learning the roles of teacher and student shift. The teacher becomes a facilitator who guides students in learning instead of the sage who dispenses information. With technology all students can become active participants in learning, including students with disabilities.

Cooperative learning is a teaching strategy in which students work together in groups on a variety of activities to learn information, practice skills, create a product, or solve a problem. Students of different abilities have roles within the group and are responsible for helping their teammates learn. When students work together in teams, research indicates that they achieve more, and develop supportive relationships, good communication skills, and higher level thinking abilities. Teachers can use cooperative learning with any grade, with students who have diverse abilities, interests and backgrounds. It is important that students learn how to work productively with others and to communicate effectively. Technology is a powerful tool for helping students collaborate on a wide variety of activities.

Individualized learning is a strategy which allows teachers to meet the diverse needs of students who learn in a variety of ways and at different rates. It addresses the differences in learning styles of all students and provides for the special needs of students with disabilities. Students learn by experiencing, reading, writing, listening, experimenting, manipulating, watching, discussing, reflecting. They may need to draw, sing, dance, compose, build, write, or act to demonstrate what they know. Teachers can offer learning experiences which honor the many different ways that students learn and assessments which honor the many different ways that students can demonstrate what they have achieved. Technology offers tools which address the learning styles and rates of all students. For students with special needs technology may provide the experiences and assistive devices which allow them to perform like their peers and succeed in meeting their goals.

There is so much information about a topic and so many topics in any area that students may "cover" the material in a subject area, but never really understand it or be able to apply it to real world problems. Integrated curriculum helps students make connections from one area of study to another. Integration of the curriculum implies more depth of knowledge, more connections of knowledge within a subject area and more connections of knowledge across disciplines. (Robin Fogarty [1991] describes twelve different models of integrated curriculum.) Teachers often work together to create learning environments which foster integrated curriculum. Some special schools and projects have been reorganized to offer all learning in an integrated setting. In some schools teachers from different subject areas team together to provide this instruction. Sometimes an overall theme connects lessons together for achieving greater understanding of a concept. Technology tools can help students gather information from diverse content areas, from experience, and use that information to solve real world problems.

It is also critical that the curriculum be relevant to students' needs and address real world applications. School may look very different as the community becomes a natural extension of the classroom. Students may be in a boat gathering data from a nearby lake for their chemistry class. They may be using a communication device or personal digital assistant as they shop in a local discount store. Classrooms may also look very different as students learn academic subjects through real world applications of state of the art technologies.

Providing a Vision

In order to help preservice and inservice educators visualize some of these settings, this laserdisc was developed. The videodisc format was selected because it is a familiar technology in most Florida schools. Every Florida school has at least one laserdisc player with barcode as well as level 3 computer compatibility (Pioneer 2200). Many schools own more than one player. The videodisc in its CAV format holds one hour of full-motion video, 54000 still frames with graphics, still images or text, or any combination of these along with two independent audio channels. The videodisc format lends itself to use as an extremely flexible stand-alone tool when used with barcodes as a level 1 device. And it is possible to repurpose the level 1 disc at a later date and to create instructional materials and/or assessment tools through the use of any of several hypermedia authoring programs such as *HyperStudio, Linkway Live, Multimedia Scrapbook*, or *HyperCard.*

The video clips selected for use on the videodisc provide models of effective learning environments: active learning, cooperative learning, interdisciplinary learning, and individualized learning. They demonstrate the effective uses of technology within those environments for students of all ages with a diversity of special needs.

Video clips included on the disc were collected from a variety of sources: FDLRS Centers throughout the state of Florida who work with teachers and exceptional students; videotape collected in workshops and during site visits to schools throughout the state; raw video footage collected for *Connections Live!*, a quarterly video news magazine about technology in Florida schools produced by the University of Central Florida; and video shot expressly for this videodisc.

The videodisc begins with an introduction to the disc, an overview of potential uses, and a statement of objectives. This is followed by the videoclips, each introduced by a graphic title. For example, one clip captures three and four year old students working cooperatively at the computer. They need little prompting as they each perform a task to turn on the computer and get the program up and running for their lesson. They practice turntaking and social skills as they make choices and react to the lesson. These young children all experience significant delays in their language development. The teacher uses the computer as a powerful tool to elicit spontaneous language, develop their vocabulary, and review concepts they are working on in the classroom. This very effective video clip demonstrates that even preschoolers can use the computer independently if they are trained, and if the activities developmentally appropriate.

At some times, both audio channels were used: one to provide actual audio from the classroom, and one to provide commentary. In addition, a *PowerPoint* presentation about the use of technology in meeting the needs of all students was included as video stills to provide a readily available tool for presenters.

Some of the settings provided on the videodisc are rich in technology. They are included to make educators aware of the powerful experiences schools can offer when they have access to the necessary tools. Hopefully, they will raise expectations for access and encourage educators to plan for acquisition. Other settings have less or older technology. They represent the real world for too many educators. These settings demonstrate that almost any technology can provide meaningful learning experiences if it is used appropriately in good learning environments.

Lessons Learned

One of the difficulties encountered in developing this laserdisc was finding appropriate models which covered the spectrum of technologies, instructional settings, learner needs, and age levels adequately enough to provide a usable product. At the same time, it was difficult to edit the many hours of videotape available for use down to the precise moments which would provide a comprehensive enough look at the environment to provide models worthy of examination. Additional difficulties resulted from the inexperience of the writers in creating a videodisc product and from trying to accomplish too many goals with one product. The result, however, is a unique and valuable product which can be used in demonstrating to teachers and administrators how technology can be infused into instructional settings to provide rich and varied experiences for *all* learners. It is a flexible tool which can be used in both preservice and inservice teacher education to help educators visualize access through technology, the use of technology in a variety of strategies for instruction, and truly inclusive environments.

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Technology for Educators: A Graduate Program for Research and Practice

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In 1982 the Division of Education at Johns Hopkins University offered elective courses in computer programming to teachers enrolled in graduate education programs. The initial programming courses included BASIC, PASCAL, and LOGO. Later offerings expanded to include courses such as computer literacy, instructional design, software review and evaluation, and teaching writing using a word processor. As the popularity of technology in schools increased, the number and diversity of course offerings also increased. A combination of Apple II+'s and IIe's were acquired for a teaching lab. A Master of Science degree was established with 33 credit hours required. Summer programs were designed for intensive course work completed in summers and project credits earned during the school year. Special educators in the Division of Education developed courses that focused on applied behavior applications and assistive technology. Technology for Educators graduate program at Johns Hopkins flourished with the highest enrollments in the Division of Education.

Keeping up with the rapid changes in technology quickly became a major obstacle to maintaining a "state-of-the-art" program. As technology began to emerge in area school districts, the lab equipment was not as new as the computers going into schools. Software was newer, "glitzier," and more user-friendly than that available in the graduate program.

Currently, the Master of Science degree provides opportunities for teachers and other educators to develop areas of specialization in technology to enhance their teaching and leadership skills. The program prepares teachers to integrate the use of computers and related technologies into classroom instruction. Some courses have an assistive technology focus for use with children needing special devices for access, mobility, and communication. Courses include hands-on experiences combined with lecture, demonstration, and discussion. Also explored are applications of research and best practices on how technology can be used to enhance learning for all students. Policy makers, legislators, technology developers, and practitioners' perspectives are integrated through out the program. Graduates of the program are qualified to become school-based leaders in the uses of technology and in the organizational changes necessary for integrating technology with the curriculum and instruction.

New Directions

The goals for the Technology for Educators Masters program reflect the mission of the Center for Technology, Johns Hopkins University, "To empower children and youth with special needs to achieve their full potential, through technology, in an ever-changing society." The goal of improving the education of children is an important underpinning for a teacher training program.

Goal One: *To assure equal access, through the use of assistive and instructional technology, to a full range of educational opportunities at home, school, work, and in the community.* The program reviews research and effective practices of equity and technology issues involving access to instruction as well as assessment of learning for all students. Given the premise that all children can learn, training in the use of technology assures that teachers are prepared to provide appropriate opportunities and measurements of that learning. Both general education and special education teachers learn about the latest developments, research, and measurements of that learning. Both also learn about the latest developments, research, and practices that technology offers to extend children's productivity and thinking skills. Courses are designed to offer specialized technical training in such areas as assistive devices and performance assessment packages.

Goal Two: *To transform instruction with the help of technology to create a child-centered learning environment that meets the diverse needs of each learner and improves the outcomes for all students.* The program explores the role of technology in current educational reform efforts. Technology is transforming the basic skills necessary for becoming productive adults. Children in schools today need to learn how to access and analyze resources. Proper interpretation, application, and synthesis of information is critical for appropriate and responsible problem solving and decision making. Sources of information are profusely expanding as electronic communication networks become more commonplace. Teachers need training in these new resources to facilitate their students' learning experiences. Strategies for teaching critical reading and thinking as well as organizational and communication skills have never been more important. The Bureau of Labor claims that these are the skills that insure employability. Teacher training takes on a new dimension as technology permeates education. Every curriculum area and every teaching method in the transformation of instruction focuses on the development of each child for appropriate preparation for the future.

Goal Three: *To create dynamic leadership and organizational support, using the full range of technologies, that promote school reform to meet national and state educational goals and to assure quality education for every student.* To prepare graduates to assume leadership roles in schools and school systems, the program provides training in leadership, planning, and staff development. Courses are designed to address current educational reform movement issues with opportunities for individual teachers to consider the feasibility of reform in their particular situations. These opportunities gives graduates experiences in planning within the constraints of the policy, philosophy, climate, mission, goals, and budget of their own school environment. Technical information is relevant to planning for effective and efficient uses of technology. Participation in cooperative learning projects, class demonstrations, presentations and discussion groups contribute to teachers' preparation for delivering staff development. Peer interactions and networking increases teachers' expertise and confidence in their abilities to use technology. Leadership and support are more effective when based on knowledge and personal experiences with technology.

Next Steps

To ensure that the Technology for Educators goals are realized to fully benefit the schools in the Baltimore/Washington area, strategies to improve and update the program are underway. These include identifying the skills and expertise teachers need to use technology effectively with their students and to develop training solutions to meet these needs. The needs and solutions will be identified through a series of focus groups with school administrators, computer coordinators, principals, curriculum supervisors, university professors, instructors, and former students. Groupware will facilitate the collection and organization of ideas and priorities.

Secondly, alternative delivery logistics will be explored. Portions for the program may be taught on-site at local schools. This customized training will have access to the installed-base technology configuration and strategies will address the unique characteristics of the school population. The use of distance learning and telecommunication will also be expanded. Students will have more choice of campus locations for attending courses with distance learning network installations. Students automatically receive Internet accounts as part of their enrollment benefits. Courses will extend use of the telecommunications networks for more frequent and intensive interactions.

Thirdly, guidelines for seminars, practicums, and graduate projects will be developed and standardized to reflect national and state standard teaching competencies. Faculty and staff are currently researching teacher competencies in educational and assistive technology areas published by NCATE (ISTE), the Council for Exceptional Children, and other professional organizations. These guidelines will include steps for evaluation and assessment of effective applications of technology. Observations, research, and experiences will focus on student outcomes.

Finally, graduates will participate in assessment strategies involving portfolio assembly and presentation. Students will assemble projects, assignments, observations, and experiences from the program and present the portfolio of their accomplishments to peers, university faculty, and staff of the school.

Summary

As new technologies, research, and effective practices emerge, teacher training programs will need continual evaluation and modification to keep pace with the field. The Masters' degree program at Johns Hopkins University will focus on technology for improving the education of all children. Participants' competencies for using technology will enhance their teaching skills and prepare them to assume leadership roles in schools. The program is designed to be responsive to the training needs of schools as they endeavor to provide effective education for all children.

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Three-minute Videos: Effective Solutions for Reducing Anxiety and Promoting Achievement

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We are faced with teaching two very different courses in our teacher education program in which experiential learning components, that the students perceive as being significantly challenging, are mandated. One course, *The Teacher and Technological Advances*, requires students to develop technology-infused project presentations: in-depth, instructional, developmental lessons or small units which incorporate various forms of technology and media. In these culminating presentations students demonstrate how well they can synthesize and integrate pedagogical theory with classroom practice dealing with modern, innovative technologies of instruction which are discussed, read about, observed, and used throughout the course. Working individually or in small groups, students create, present, demonstrate, and share their ideas, plans and instructional materials with one another as well as their instructor. The second course, *Developing and Adjusting Instruction for Moderately and Severely Handicapped Learners*, occurs during an intensive field-based, four-week summer immersion program. Students investigate how basic learning and instruction principles can be used to meet special learner needs. In addition, students are required to design an interdisciplinary curriculum for learners with varying disabilities. For instance, learners may be nonverbal, confined to wheelchairs, or severely cognitively impaired. The curriculum is theme-centered and must address one or more of the learners' Individualized Educational Program (I.E.P.) recommendations.

Common Problems

Despite the diversity of our courses' contents, as instructors we share two common problems. We recognize, first, that in order to achieve greater levels of success, our students need to be able to visualize *in advance* what they are expected to perform or produce by the conclusion of their educational experience. For example, in the technology course, students need to be made cognizant of the variety of media products they can select, modify, and design for their projects (Heinich, Molenda & Russell, 1993); moreover, they need to be able to envision the situational context or forum in which their presentations will be delivered. Whereas, during the first session of the adjustment course, students need to vicariously meet special needs learners, understand some of the procedures they will be expected to follow, and become familiar with the learning environment that they will shortly encounter firsthand.

Our second problem deals with more affective concerns. In both courses, many students enter with preconceived, inappropriate perceptions regarding either modern classroom technology or special needs learners. For instance, some students may be reluctant to handle camcorders or computers for fear of breaking them or making what they perceive as unintended, foolish mistakes. Others may have taught or been educated in schools where technology-infused instruction was virtually nonexistent, and thus may feel that technology is irrelevant to effective education. Still others may have never become intimately acquainted with a disabled child either *in* or *out*side of a classroom setting, and subsequently feel uneasy because they do not know what to expect or how to behave. Such attitudes tend to inhibit the kinds of creative risk-taking and student-teacher interaction we strongly encourage in our teacher education program.

Video Solutions

Therefore, in order to deal with these problems, we decided to develop our own three- minute videos which briefly but effectively showcase our *former students* modeling significant behaviors and competencies which are required in each of our courses. These videos were intended to increase motivation and achievement, reduce anxiety, and encourage self-efficacy within each of our students (Hilgard & Bower, 1975; Woolfolk, 1993).

The purposes of this paper are modest ones: to describe the two separate, yet related, three-minute instructional videos we produced and how we used them in assisting our learners to dispel the preconceived, inappropriate perceptions that students often harbor when dealing with novel learning situations; and to encourage our fellow teacher educators to consider creating their own, relatively easy-to-produce, three-minute pieces.

Description and Use of Video Clips

Not static talking-head videos, we intended them to be dynamic. Thus, they were shot, edited and dubbed with sound tracks not unlike locally produced music videos. We incorporated a variety of special effects, transitional devices, camera movements and types of shots. Typically each video contained a panoply of fades, dissolves, and wipes; tilts, pans and handheld camera shots; extreme close-ups, reactions, and over- the-shoulder shots; as well as freeze frames, digital strobes, and key effects. Shots, of course, varied in duration; however, most fell within the range of one and five seconds. This was done intentionally in order to keep the students' attention as well as to motivate them. We selected contemporary music to suit the pace of the videos as well as the mood.

Despite the technical similarities, the videos addressed radically different topics. Hence, there were significant differences in the look and the tone of each production due to the content. The technology videos presented a series of non-sequential shots to offer the students a glimpse of what they could do with media during their subsequent presentations. For example, the videos highlighted uses of student-generated overhead transparencies, videotapes, interactive videodiscs, multimedia, and sound/slide presentations, as well as more traditional media such as drymountings, laminations, audiotapes, still photos, handouts, and assorted realia.

Figure 1.

Figure 2.

Figure 3.

In contrast, the education video, "Partners," was a linear narrative depicting the daily activities for student teachers and special needs learners who participated in a prior summer immersion program. The shots showcased the exceptional learners interacting with each other — and the student teachers — in a variety of situations, including teaching episodes dealing with cognitive concerns, as well as self-help issues of feeding, dressing, physical education and recreation activities.

The videos were shown during the first session of each graduate course and thus served as advance organizers. In the graduate technology course students first viewed one three-minute video clip, then read a detailed set of instructor guidelines pertaining to the capstone, technology-infused, project presentations. After lengthy discussion, students viewed another three-minute video. This second, similar video was presented, in order to assist students in further conceptualizing the possibilities for their final projects.

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Figure 4.

"Partners," the education video, in contrast to the technology videos, was not shown at the lesson's entry; rather, it was presented at a strategic moment when the graduate students began to raise specific questions regarding their intended practicum experience.

What Happened?

Did the videos serve as effective advance organizers, ones that assisted the graduate students in envisioning the "gestalt" — the whole experience — so they could strategically work toward the course goals? And, did the three-minute videos effect appropriate attitudinal changes in our graduate students? We believe that they did. However, we realize that we can only offer tentative answers to those questions. Due to the nature and scheduling of the two courses we did not collect quantifiable data. Nonetheless, we did carefully observe the students' behaviors as the courses evolved.

The videos focused student attention on the tasks at hand, and to the extent that the clips prompted them to raise many questions dealing with the broad scope of their impending presentations and experiences, we believe that the videos did serve as useful advance organizers. When we began fielding questions such as, Who exactly is the audience for this presentation? and What will I do if I can't look a handicapped child in the face?, we recognized the fact that our students understood central course goals.

In addition, we believed the videos helped to create upbeat, positive, classroom climates, ones that nurtured student confidence. Students responded particularly well as they recognized student predecessors — their "distant peer group[s]" — who appeared on screen, and who had successfully completed projects and experiences of an identical or similar nature (Kindsvatter, Wilen, & Ishler, 1992). Further, students believed that what they observed in the videos was challenging, yet achievable and relevant to their lives.

Conclusion

Since the overwhelming majority of our students came to our courses with little or no prior experience using technology or interacting with handicapped learners, the videos provided them with vicarious experiences upon which to make judgements regarding themselves and their abilities. Students value hands-on, experiential approaches to learning; however, there are times when a direct engagement with specific curricula may appear daunting. We believe that our videos served as effective, iconic bridges or scaffolds which enabled our students to move beyond what they *thought* they could accomplish, to what they actually *did* accomplish in our two courses.

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Addressing Attention-Deficit/Hyperactivity Disorder Through Technology: Implications for Teacher Education Programs

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Attention-Deficit/Hyperactivity Disorder (ADHD) - what is it? Who has it? How do we teach students with it? Can students with ADHD become efficient learners? Is it a learning disability or is it a companion to a learning disability? These are some of the more perplexing questions plaguing educators and researchers today. Due to the considerable variability among students with ADHD, there is significant disagreement regarding our understanding of this disorder and how to address it. This paper attempts to clarify our understanding of ADHD by defining ADHD, explaining successful instructional practices for use with students who have ADHD, describing how technology can be integrated with instructional practices, and discussing implications for teacher education programs.

Defining ADHD

Most medical professionals, clinicians, and educators refer to The American Psychiatric Association's most recent description (1994) of ADHD which includes two discerning characteristics: inattention and hyperactivity/impulsivity. Students may have either of these attributes. Specifically, inattention refers to such behaviors as: failing to give close attention to detail, lacking sustained attention in tasks or play, not listening when spoken to, not following through on instructions, difficulty in organizing tasks and activities, avoiding or disliking schoolwork or homework, losing things necessary to tasks, such as pencils, being distracted by extraneous stimuli, and forgetting daily activities. Hyperactivity, on the other hand, refers to behaviors such as fidgeting with hands or feet, leaving a seat when sitting is required, running about or climbing excessively, talking excessively, and difficulty in playing or engaging in leisure activities. Somewhat similarly, impulsivity refers to behaviors such as blurting out answers before questions have been completed, difficulty in awaiting a turn, and interrupting or intruding on others (p.85). More concisely, individuals with ADHD identify their disorder as trouble focusing on one thing, paying attention, thinking before acting, keeping still, keeping track of things, and/or learning in school.

Regardless of whether students are inattentive, hyperactive, and/or impulsive, the overriding effect on students with ADHD is that they lack the learning strategies necessary to succeed in school. In essence, Quinn and Stern, (1991) state that students with ADHD have difficulty accessing and coordinating the cognitive abilities necessary to become efficient learners.

Instructional Practices

A number of professional organizations have taken positions on appropriate educational interventions for students identified as having ADHD. For example, Lockerson (1991), has indicated that successful practices should increase the attentional value of the specific lesson material, decrease the attentional value of materials irrelevant to the lesson, and provide a structure that makes expectations as consistent and predictable as possible. Such practices will assist students in becoming more efficient learners.

Additionally, a number of interventions have been developed that can assist inefficient learners to use effective learning strategies. Three of the more prominent techniques used in classroom and clinical settings are self-instructional training, self-monitoring, and strategy instruction. Self-instructional training is a method of developing verbally mediated self-control which consists of verbal statements to prompt oneself or direct one's behavior. The behavioral components of self-instructional training include modeling, successive approximations, graduated difficulty prompts, feedback, and social reinforcement (Harris, 1982). Self regulation is stressed and students are trained in the use of private speech. Private speech is used as a guide, and control over behavior is gradually faded from overt verbalizations by an adult to covert verbalization by the student.

Meichenbaum and Goodman (1979) state that training is built around four basic steps:

1. *Cognitive modeling*: The adult model performs a task while talking aloud while the student observes.
2. *Overt guidance*: The student performs the task using the same verbalizations, assisted by the adult at first, then alone.
3. *Faded self-guidance*: The student whispers the instructions (often in an abbreviated form) while going through the task.
4. *Covert self-instruction*: The student performs the task, guided by covert self-speech.

Self-instructional training has demonstrated the most promising results with attentional problems and with the development of impulsive behavior. In general, self-instructional training has shown promise in establishing inner speech control over a number of behaviors associated with ADHD such as attention to task, impulsive responding, and disruptive classroom behavior.

Rosenbaum and Drabman (1979) describe a second technique called self-monitoring. In self-monitoring or self-recording, a behavior is monitored and recorded by the individual. Kauffman (1993) describes how it has been extensively used to assist students who have difficulty maintaining task-orientation. The technique typically begins by teaching an individual or small group to record the occurrence or non-occurrence of a target behavior such as attention to tasks. The student or group is then taught how to use a cueing tape, a tape recorder, and/or self-monitoring record. Each time a student is cued, he or she is to silently ask, "Was I engaged in the target behavior?" and to mark the record appropriately. Lloyd, Landrum, and Hallahan (1991) through a number of research efforts have demonstrated that self-monitoring interventions help to manage and resolve some of the troubling behavior of students with ADHD.

A third technique is strategy instruction. Strategy instruction, a method for teaching students specific learning strategies which help them to acquire, comprehend, and retain knowledge, has shown significant promise. Deshler, Schumaker, and Lenz (1984), Deshler, Schumaker, Lenz, and Ellis (1984), and Schumaker and Lyerla (1991), for example, have found that a core group of strategies can be taught to students to enhance their academic and social functioning. This core group of strategies includes seven key components: motivation, acquisition, generalization, curriculum, communication, transition, and evaluation. Using these key components, these researchers have developed strategy-based instructional packages to promote basic academic skills such as reading comprehension and writing of sentences and paragraphs.

Although self-instructional training, self-monitoring, and strategy instruction have been successful in assisting students with ADHD to become more efficient learners, these practices are not without their flaws. Each of these practices is a labor intensive process which requires considerable teacher-student interaction. A teacher cannot expect learners with attention deficits to acquire and master the use of a strategy by merely "telling" or making them aware of it. Considerable direct instruction and significant amounts of practice with the strategy are necessary if students are to acquire and use it regularly. Moreover, much of the practice needed falls into the category of "controlled practice," that is; prompts, guiding questions, feedback, and repetitions to assure acquisition of the material taught (Barnes & Rosenberg ,1985). The need for such intensive instruction for strategy acquisition and generalized use has prompted Graham (1983) and Robin, Armel, and O'Leary (1975) to claim that self-instruction and strategy instruction procedures are not cost-effective.

Integrating Successful Instructional Practices and Computers

One way to address the cost-effective and labor-intensive issues of strategy-based instruction is to combine the procedure with the microcomputer. The benefits of the computer have been clearly noted in the literature since the 1980s. For instance, Schiffman, Tobin, and Buchanan (1984) indicated that computers are: user friendly and nonthreatening, give students their undivided attention, allow students to learn at different rates, provide reinforcement, corrective feedback, and immediate praise, provide drill and practice activities, are well suited to the discovery method of learning, assist students in developing problem solving skills, and help students focus attention on tasks.

Many of the characteristics of the computer address the unique needs of students with ADHD. First, students do not have to raise their hands and wait for the teacher to recognize them. Consequently, teachers are not plagued by students who blurt out answers even before questions are posed. Second, time limitations, which are often inappropriate for students with ADHD, can be eliminated through the use of the computer. It can allow students with ADHD to move at their own pace, however quickly or slowly. Third, students with ADHD often need immediate feedback, something which the computer can readily offer. The computer corrects the response immediately and provides corrective feedback. This feedback provides insight into the cognitive processes that students with ADHD often lack. Fourth, students with ADHD often display a great need for routine and repetitious practice. The computer can provide such practice while displaying infinite patience. It does not mind repeating itself many times. Fifth, the computer can help focus the student's attention by presenting a limited amount of pertinent information; therefore, the student does not have to distinguish relevant from irrelevant stimuli. Finally, software can assist in the development of social skills; it can model characteristics or real-life situations. These real-life situations can help students develop socially appropriate responses such as waiting one's turn, sharing, and completing activities.

In essence, the computer, unlike the teacher, can provide on an individual basis highly sequenced strategy-based lessons designed to promote individual requisite academic tasks, monitor errors, and self-regulate behavior. Moreover, the computer, which is uniquely suited to providing controlled practice, can provide students with prompts, guiding questions, feedback, and repetitions. These features are essential to strategy-based instruction if students are to acquire and use the strategy effectively. In short, the combination of the computer and strategy-based instruction can make students with ADHD aware of their own thinking processes, develop a plan of action prior to reacting, and monitor and evaluate whether or not their plan of action is appropriate or effective. If these instructional practices are to continue to be successful, new efforts must seek to integrate self-instructional training, self-monitoring, and strategy instruction with the computer.

Implications for Teacher Education

In order to incorporate strategy instruction and technology into the classroom and address the needs of students with ADHD, two significant changes must occur in existing teacher education programs. First, teacher educators must have specialized training in technology, strategy instruction, and the practice of integrating these components across curricula. Secondly, higher education personnel must model such practices by incorporating technology into their courses.

Many existing teacher education programs contain isolated components and are sorely outdated. For example, most teacher educators are required to become proficient in instructional technology such as making transparencies, using overhead projectors, or operating a duplicating machine. Some teacher education programs go a step further by requiring students to become proficient in computer technology and its use. A typical program might include such competencies as: word processing to create instructional materials and write lesson plans; creating data bases to record, compile, and analyze student grades; using computers to perform literature searches, and performing software evaluation.

Similarly, many existing teacher education programs require students to become proficient in classroom methods of instruction. At a minimum, students are required to write and execute lessons which incorporate techniques such as cooperative learning, think-pair-share, inquiry learning, concept attainment, discovery learning, simulation, and other teaching strategies. Few, if any of these courses, focus on techniques which address the specific needs of students with ADHD — strategy instruction. Recently, this lack of focus led The Council for Exceptional Children's Division for Learning Disabilities to include these suggestions regarding the training of teachers of students with ADHD. It is the DLD's position that future teachers acquire "a thorough understanding of the physiological and psychological aspects of attentional theory, as well as competence in identifying and selecting intervention strategies for specific individuals (Lokerson, 1991).

Still, many faculty in higher education do not incorporate technology and instructional methods into their courses. For instance, a recent study indicated that only 16% of college courses use computer labs, 11% use commercial software, 9% use computer simulations, 8% use electronic mail, 4% use CD-ROM materials, and 4% use multimedia (DeLoughry, 1994). Thus, it is not surprising that the integration of technology and strategy instruction is lacking in many teacher education programs since so few higher education faculty utilize technology in their own instruction. If teacher educators are to integrate technology and instructional strategies into their classrooms, then higher education faculty must serve as models. Given the growing population of students with special needs, particularly ADHD, it becomes increasingly evident that teacher programs must redirect their efforts if future teachers are to be effective in the classroom.

In summary, ADHD is a condition which has gained notoriety only recently. Although it has not been recognized formally as an exceptionality, it is nonetheless deserving of further research. Specifically, future educators and teacher education training programs must address what ADHD is, what instructional strategies can be used with students who have ADHD, and how technology can be integrated with instructional practices.

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Computers as Tools for College Courses: A Pilot Study

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This study was undertaken to examine the content acquisition resulting from computer-based activity versus that from a study-guide activity. In addition, students' feelings and attitudes toward the activity were collected. The findings suggest that in terms of content acquisition, it makes little difference if the text-based information is provided on a computer screen or on a page. In general, students felt more comfortable with page-based text. However, they were intrigued with the multimedia possibilities the computer-based activities could offer.

Literature Review

With the breakneck pace at which technology is being advanced into the world of higher education, within five years, highly tailored-to-suit textbooks and tutorials drawn from publishers' menus will be accessible on CD-ROM for college students. Will these online formats lead to more efficient or effective learning? Or, will the instructional consequences of the medium be left for post-hoc analysis? Will the promise of technology be kept?

Duffy, Trumble, Isenberg, Janik, and Rodgers (1987), in fact, found that more efficient long-term learning took place when learners used the hardcopy format, even though they found some greater efficiency on immediate performance. Their study examined the power of online instruction versus that of hard copy in a study using a task-based tutorial designed to teach application software (CADCAM). Their results are consistent with that of other researchers investigating this question from a variety of learning perspectives (Cohill & Williges, 1985; Dunsmore, 1980). Robertson and Akscyn (1982), in a related study involving a series of benchmark tasks, also found more efficient performance on a retention test for those who used the hardcopy format and no difference in the time required for students to complete the tasks. Repeatedly in these studies, hardcopy formats for tutorials excelled in overall efficiency and effectiveness over the long-term.

Students' attitudes also cannot be ignored. Novice users are apt to feel stunted or frustrated next to their experienced counterparts if required to learn using an online format. Learning theory would suggest that these kinds of attitudes would adversely affect learning outcomes. Relles (1979) attributed the high performance effects he found in tutorials involving drawing systems to exactly that: the previous experience and confidence of his learner subgroups.

Why does hardcopy excel as a medium in all of these studies? Duffy, et al. (1987) reported at least six possible explanations: a) it takes longer to read a screen display than it does a comparable page of text; b) it is more difficult to skip pages and may be more time consuming depending on the system response time; c) searching, reviewing (i.e., going back) may take more time; d) the font size and amount of information on a page may affect reading efficiency; e) it takes greater cognitive effort getting to and glancing back at where one wants to be while involved in the content; f) it may be a memory issue, perhaps requiring greater short-term storage, but with less transfer to long-term storage. Jafari (1992) also cites the reliability of the technology as a potential factor in users' responses.

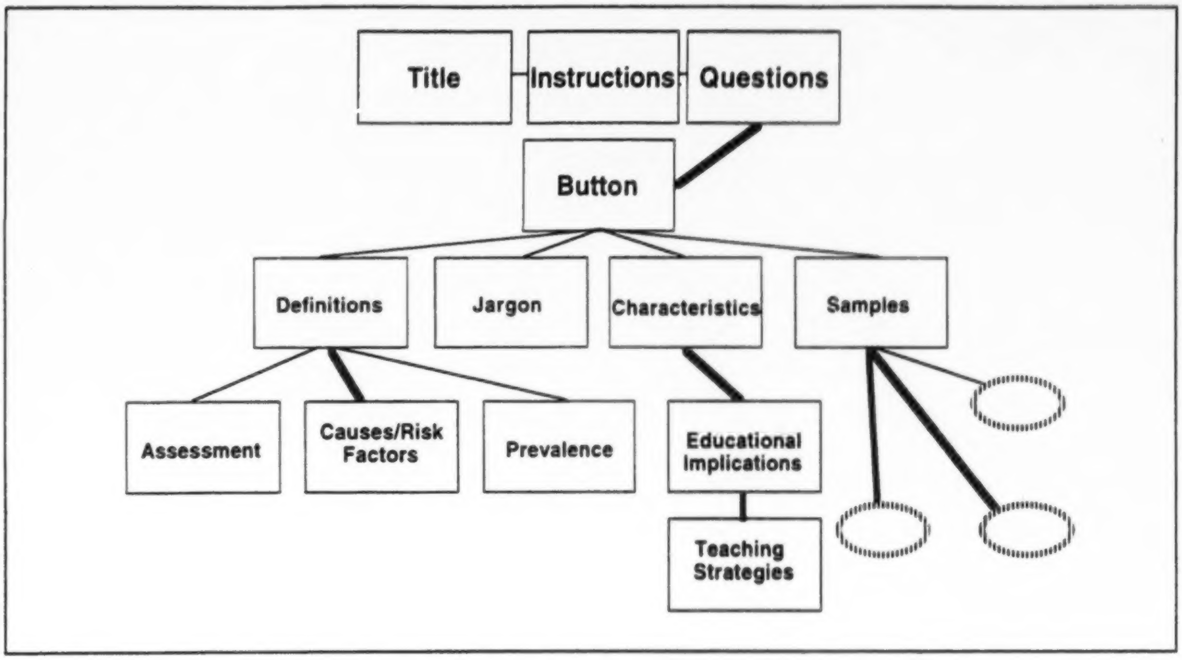

Figure 1. Structure of cards and links

As suggested above, the attitudes and experience level of the user are also apt to provide insights into the advantages of the hardcopy medium for tutorials. These explanations may be perceived as roadblocks to using technology in the learning process; or, more optimistically, they may serve as lightposts pointing out where software designers can focus their creative efforts. The value of online tutorials in relation to a hardcopy format will be the focus of this study.

Setting

The authors teach an undergraduate teacher preparation course titled Introduction to Exceptional Children. This course presents information on each of the 13 or 14 categories of exceptionality recognized by state and federal law. Much of the information that is presented about each exceptionality is repetitive in nature. Because of its repetitive nature, this information is often difficult to present effectively. More problematic is the fact that each of the categories generally receives an equal share of class time. Thus, prospective teachers get as much time on disabilities with a very low incidence (i.e., those which they may see once in their career) as they do on disabilities with a high incidence (i.e., those that they will see every year of their professional life).

The authors felt that a stand-alone presentation developed for independent use at a computer work station could reduce the repetition and release additional class time for a) a stronger emphasis on the disabilities which have a high incidence b) more interactive activities and simulations, and c) additional speakers and videos.

In addition, the computer work station offers the opportunity to incorporate a richer sensual environment than a textbook or worksheet. Through the use of audio and video samples, the preservice teachers could be presented with samples of student behavior displayed in a sensually thick fashion instead of the vignettes and anecdotes used in traditional text presentations where written language is supported only with still pictures.

For these reasons, the authors began a line of inquiry which would allow them to develop and use stand-alone computer-based activities for independent use by their students. The authors surmised that the process might eventually realize a great savings in time, but that it would not be easy or cheap; therefore, they elected to take a methodical approach to the development. This study is the first in a three-year series designed to produce and validate a series of multimedia computer-based activities for the independent use of students in an introductory special education course.

The purpose of this initial study was to explore two issues. First, the authors wanted to see if content presented through the computer was assimilated as well as the same content presented in a paper-based study-guide format. Second, they sought to collect information regarding the feelings and reactions of the participants to the computer-based presentation and to the importance of the multimedia presentations which were incorporated into them.

Interventions

Computer-Based Study Guide

In order to accomplish these purposes, three HyperCard stacks—one containing information on Learning Disabilities (LD), one on Mental Retardation (MR), and one on Communication Disorders (CD)—were created. The development process was accomplished by identifying the types of information needed for each category of disability. Once the information was identified, it was gathered from a variety of sources, the primary source being Educating Exceptional Children by Kirk, Gallagher, and Anastasiow (1993).

Specifically, the content of each stack started with a set of focusing questions. These questions were designed to help the learner focus on the critical information for each category. Next, information on the federal definition of the disability. This definition is the one used for funding purposes. Second, information regarding strategies and problems in assessment was provided. Third, information about the causes or factors that put a person particularly at risk for a disability was presented. Also included was information about the prevalence of the disability. Technical vocabulary was defined and typical characteristics of the disability were described. Finally, educational implications and teaching strategies were very briefly discussed.

The stacks were all designed with an identical structure, so an empty "shell" stack was created with all of the appropriate links and fields but no information in it. The category specific stacks were created by inserting the information into a copy of the "shell" stack. Thus all stacks are identical (except the CD stack which contains sound samples) containing 13 cards (except the CD stack which has 14). Figure 1 illustrates the links between the cards in the stacks.

Each rectangle represents a card. The text describes the type of information each card holds. The lines illustrate the links between cards. All of the links are two way with buttons to navigate from card to card. The actual stacks used are being submitted for publication on the CD-ROM of the conference proceedings.

The LD and MR stacks were exclusively text-based while the CD stack included the text on the same topics, but was enhanced with a series of sound samples (represented by ovals in Figure 1) taken from clinical sessions. Tapes of various clinical sessions were reviewed by a speech language pathology intern and selections representative of communication problems in articulation, fluency, and voice were selected. The sound was digitized through the microphone on a Macintosh and processed using the sound palette in HyperCard. One of the technical issues that created problems was the allocation of memory to HyperCard. In order for the sounds to play, the memory allocation for HyperCard had to be increased to 2,000k.

Paper-Based Study Guide

For LD and MR, equivalent paper-based study-guides were devised containing only the text information. The guide for MR was seven pages long, and the guide for LD was eight pages long. The guides were laid out with exactly the same information as was included in the computer-based activities. The type size was slightly larger, but format issues were kept as similar as possible.

In spite of the efforts to keep the formats as similar as possible, several differences were inevitable. Some of those differences have been documented by Duffy (1987). They include differences in the number of pages—while the paper-based guide had only 7 or 8 pages, the computer-based guide had 13 or 14 cards. This is a result of the differences between the standard HyperCard card size and the 8.5 by 11 format of paper. Another difference is that scrolling fields were used in the computer-based guide. This made it impossible to see the entire "page" at one time while of course with a paper format, the entire page or even multiple pages could be reviewed at once.

A second difference noted by Duffy (1987), that of highlighting strategies, was minimized. The types of formatting strategies used to highlight headings and other important sections of text was kept as standard as possible across media. The were confined to type size, bold, and italics. They were not applied exactly the same in each medium but were applied as consistently as possible.

The final difference was the learning load required of the user. Without exception, the vast majority of students in college classes can be assumed to have mastered the use of paper formats. That mastery cannot be assumed with even simple point and click computer applications. As one might expect, our group included many students whose computer experience was quite sophisticated and several who were sitting at a keyboard for the first time.

Subjects

These two interventions were presented to the students in one section of the course "Introduction to Exceptional Children". This section was offered during the spring semester of 1994 and was taught by one of the authors, Peggy Anderson. Table 1 shows the demographic information collected by student group and for the total sample.

The gender of the participants reflects the gender of the population entering teacher education. There is a predominance of females and fewer males. This split is consistent with the current teacher population if not with the population in general.

Normally, the students taking this class would be in the first semester of their junior year of college. Most of these students were, however there were several who were officially listed as sophomores. This may be due to the that this particular section of the course was offered during the spring semester; it is usually a fall offering.

The student's majors were about evenly split between elementary education and various secondary education areas. The secondary areas included: English, Spanish, math, social studies, and French. There was one student undecided (in Group A) and one student in each group with no record (most likely a graduate student taking the course for recertification purposes).

Wichita State University is a metropolitan university with a large commuter population. Many of our students are "retooling" for a second career. This difference is reflected in the average ages of the students involved in this study. Although they are older than many schools of education, they do not differ significantly from the average

age of students at Wichita State University.

Table 2.
Demographic information on subjects by group.

		Group A	Group B	Total
Gender				
	Male	5	4	9
	Female	10	10	20
Class standing				
	Sophomore	2	4	6
	Junior	12	10	22
Majors				
	Elementary	7	9	16
	Secondary	8	5	13
Age				
	Mean	26.2	24.5	25.5
	Range	20-38	19-41	19-41

Procedures

Method

The 29 students in the section were divided into two groups, Group A and Group B. Each groups had at one experience with the text only computer-based activity (either LD or MR). If they used the computer-based activity for one, they used the paper-based study-guide for the other. Both groups had experience with the CD computer-based activity which included the sound samples. Table 2 shows how the groups were distributed for the study.

Table 2.
Group assignment to treatment condition.

	LD	MR	CD
Group A	HyperCard	Paper	HyperCard
Group B	Paper	HyperCard	HyperCard

Both the computer-based and paper-based activities were completed during the time assigned for the class final. Those two hours were evenly divided across the three activities. The computer-based activities were completed in the college MacLab which consists of 22 Macintosh LC type of computers all networked. The HyperCard stacks were placed on the network and then downloaded to each individual station. Each station had a copy of HyperCard which had its memory allocation adjusted to accommodate the sound samples and the appropriate stacks. When the students in Group A entered the lab, they chose a work station which had the first screen of the appropriate stack open. They were then instructed to explore the stack as they desired. They were reminded that there would be test over the information at the end of the time.

While students in Group A were in the MacLab, students in Group B were in a separate classroom studying the appropriate paper-based study guide. Their instructions were to use the study guide to prepare for a test over the information.

Once the groups had spent the allotted time on the study guides, they were switched and Group A went to the classroom and examined the paper-based study guide while Group B went to the MacLab and examined the computer-based activity.

Dependent Variables

Two data sources were used. The first, a content test of 20 points, was used to compare the text-based format with the computer-based format in terms of content acquisition. Three tests, (on LD, BD, and CD) were prepared. All three tests were matched on format and content. These tests were being submitted to the CD-ROM version of this book. The original plan was to compare the group means using a 2 x 3 ANOVA.

The second, more qualitative data collection tool, was a questionnaire designed to elicit the students' feelings and reactions to using the computer format to gain information. In the questionnaire, participants were asked to identify which format they found most helpful in preparation for the quiz. They were also asked to comment on the pros and cons for each format. They were asked to identify the most interesting and most difficult part of today's experience as well as to comment on why it was more interesting or difficult. They were also asked to select their preferred format for study and quizzes. Finally, they were asked to predict for which test they received the highest score and on which they learned the most. The open-ended items from the questionnaire were analyzed using HyperRESEARCH, a HyperCard stack designed to allow qualitative analysis of open-ended responses or interviews. The responses to the questions were each coded into categories and the categories were examined for viability.

Results

Content Test

Table 3 shows the means for the various groups involved in the study. Preliminary examination of the means and standard deviations showed such a small difference between the groups that no statistical analysis was performed. The assumption was that there would be no statistically significant difference and even if there were, it would not be educationally significant.

Table 3.
Group means (and standard deviations) by topic

	LD	MR	CD	
Group A	(n=15)	16.3 (1.869)*	15.6 (2.186)	15.0 (2.443)*
Group B	(n=14)	16.3 (1.730)	15.1 (1.730)*	14.8 (2.259)*

Note: *Computer-based activity

Questionnaire

For both groups there was an overwhelming preference for the print version of the study guide. Out of Group A only 5 out of 15 students preferred the computer-based format. In Group B, no students reported preferring the computer-based format.

Students shared several reasons why they preferred the printouts. The most frequently shared reason was that the print format was familiar. Comments such as "being used to it . . ." were noted in responses. One of the most succinct expressions of this idea was "It's familiar and requires no time to adjust to the manner in which the material is presented."

Other reasons included feeling more independent with the print material, being able to underline the print, finding the print easier to read and being better able to manage the study time with the print. There were a total of 45 comments identified as printout pros.

There were only 25 comments identified as cons for the page-based study guide. The most frequently occurring category of comments dealt with the idea that the print-based study guide was boring. A total of 8 comments were classed in this category. A representative comment would be "It's the same old thing. Read and take a test." Other categories of cons included: difficulty in managing time, a poor environment, and no sound included in the paper-based study guide.

The computer-based activity had 69 comments that were coded as cons. The largest comment had to do with the environment rather than the activity itself. This activity was done in the lab late in spring on the first day that the air conditioners were used. The lab was very cold. This accounted for many of the comments. Another large section of comments was that once students began to explore the CD activity, there were a number of sound samples playing simultaneously. That made it difficult to concentrate for some students.

Another strong category of cons was having to learn the computer as well as the material. "I was too busy finding the arrows." and "I felt a bit pressured at learning both the rules for the computer and the course content in the short period of the time we had." are representative of these comments. Also included in this category were comments of general discomfort with computers. Exemplars include comments such as: "I am very uncomfortable with computers" and "I was so nervous about working the computer I did not retain as much information."

Other category of con statements include comments on the time allowed for reading the text and the size of the text font. There were also some comments on technical problems encountered in getting the stacks to run.

There were also 56 comments that were coded as pros about the computer-based activities. The largest category of comments centered around the computer base of the activity. It seems that many people feel that as uncomfortable as it may be initially, there is some kind of imperative involved in learning to use computers. Comments listed as pros in this category included: "It was fun!"; "Very interactive and fun to use."; "Held my attention better, for the most part."; and "Interesting new way of studying."

Students also appreciated the sound capabilities of the computer. Sixteen comments were coded as pros in this category and there were no negative comments on the sound except that it was a bit cacophonic when several machines were playing sound samples simultaneously. At least one of the comments anticipated the author's goal! "I liked the sound examples. A video of the child would be perfect!"

Smaller categories of comments coded as positive for the computer-based activity included the ability to access the information, and the organization of the information. These comments are very interesting since they were listed by other people as negatives for the computer-based activities and positives for the paper-based activities.

As part of the questionnaire, students were asked to select from among three study and testing methods which they would prefer. One was to study the book and take the quizzes in class. The second was to study the book, review from paper-based study guides, and take the quizzes in class. The last was to study the book, review or study though computer-based activities similar to the ones they had just completed, and to take the quizzes on the computer when they were ready. Of the three choices, 4 students wanted the book alone, 10 students wanted the book and paper-based study guide, and 10 students wanted the computer-based study guide and test. Four students didn't respond to that item at all.

One of the most interesting results from the questionnaire was the students perceptions of which format would best prepare them for the test. These students had taken several other quizzes in the same class of the same format earlier in the year, so they knew what to expect. In spite of their actual performance on the test (see Table 3), when asked "Which chapter test do you think you did the best on today?" the students responded with the chapter for which they had not used the computer-based study guide. As can be seen by examining Table 4, all but 4 of the responding students selected the chapters for which they had used the paper-based study guide. Also included in Table 4 in parentheses is the students' responses the question "Which chapter do you actually think you learned the most about today?" The results are nearly identical to the test question.

Table 4.
Students' prediction of their best score on chapter test (and feelings about which chapter they had actually learned the most).

	LD	MR	CD	No Response
Group A	3 (3)*	8 (8)	3 (3)	1 (1)*
Group B	6 (4)	2 (3)*	1 (2)	5 (5)*

Note: *Computer-based study guide used

Discussion

In summary, relative to the acquisition of content as measured by the quizzes used in this course, it makes little difference whether the information was presented through a study-guide or a computer-based medium. Students performed as a whole about the same on quizzes in both mediums. This is confirmed by the course instructor who compared the grades that would have been received both with and without these last three chapter tests and found that only in 2 of the 29 cases would the grades have changed if these tests were not counted. It seems fairly safe to conclude that at least as far as the content of this particular course goes, the computer-based study guide does not hurt the students' acquisition of the course content.

In terms of how the students felt about the computer-based activities, not all of the conclusions are nearly as clear. Certainly the students felt more comfortable with a study-guide based presentation, but they were also intrigued and optimistic about the possibilities of the computer-based activities. Although they felt that they had performed more poorly on the quizzes associated with the computer-based activities, they seemed to feel a nearly moral imperative to learning the computer and recognized the strengths of the computer-based activity and the limitations of the paper-based study guide. For this class, at least, they may not be too happy about having to "know how to use a computer to use these [computer-based activities] easily" but they also recognized that the "audio stuff was cool!"

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AUTHOR INDEX

Abate, Ronald J. 470
Abrahamson, Trudy 308
Alexander, Karenlee 423
Allen, Gayle 115
Anderson, Daniel K. 730
Anderson, Mary S. 872
Anderson, Peggy 901
Anderson, Ronald J. 102
Anderson, Susan E. 13
Atkins, Sandra L. 152, 474
Atkinson, Marti 846
Austin, Linda 791, 795, 801
Austin, Maggie 227
Baggott , Linda 588, 725
Baker-Albaugh, Patti R. 483
Bao, Julie Qiu 57
Barber-Freeman, Pamela T. 73
Barnes, James 631
Bartels, Beverly 401
Bauder, Deborah 427
Baumbach, Donna 809, 889
Baumberger, Julie 876
Beacham, Betty G. 652
Beam, Bonnie J. 606
Becker, Frank 710
Bednar, Maryanne R. 894
Beers, Morris I. 690
Benghiat, Kathleen T. 477, 480
Bennett, Christene K. 434, 863
Bennett, Jack 247
Bennett, Jerry A. 434, 863
Betancourt-Smith, Maria 394
Bird, Mary 809
Blanco, Carlos A. 571
Blanton, William 618
Bodin, Joanne 3
Boice, D.C. 210
Bonham, L. Adrianne 614
Bootz, Sandy 820
Boston, Mike 219
Bosworth, Kris 488
Bouniaev, Mikhail M. 49
Bowers, Laurie 493
Boyd, Victoria 643
Bradley, Mary Jane 401
Brasell, Ray 468
Braulick, Laura 318
Breithaupt, David 244
Brewer, Sally 809
Bright, Larry K. 410
Brownell, Gregg 89, 463
Brownell, Nancy 89, 463
Bull, Glen 579, 710
Burson, Jenny 326, 404, 554
Buss, Ray R. 278, 343
Butler-Pascoe, Mary Ellen 98
Byrne, Michael M. 685
Byrum, David 287, 693
Cafolla, Ray 556
Campbell, Katy 493
Capen, Michelle 618
Capper, Joanne 786
Carlson, Randal 357, 753
Casey, Patrick J. 22, 855
Castillo-Schwartz, Patricia 29
Chen, Irene 729, 808, 575
Chestnutt, Gina 429
Chisholm, Ines M. 343
Chisholm, Inés Márquez 8
Christensen, Rhonda 186
Cifuentes, Lauren 614
Cimikowski, Linda 314
Clark, Kenneth 247
Clay, Matthew N. 764
Clay, Michael 621
Clementson, John 443
Collier, Catherine 322
Colon, Brandie 404, 554, 791, 795
Connell, Michael 1, 155, 468,
Cook, Joan 314
Cooper, Sandra B. 146
Cooper, Tara 213
Copley, Juanita 140
Coppolam, Ralph K. 191
Corbly, James E. 564
Cox, Juanita 136
Craig, David G. 561
Croninger, William R. 283
Dailey, Evelyn M. 897
Davenport, Neva Ann 215
Davis, Niki 37, 588, 725, 801
DeBlase, Vincent 163, 497
DeFalco, Susanne M. 550
Denton, Jon 735
Di Mauro, Vanessa 205
Dickey, JoAnn 217
Dickey, Steven 217
Diem, Richard A. 76
Dolly, John P. 836
Dorward, Jim 696
Downs, Elizabeth 247, 406
Drazdowski, Thomas A. 387
Dubois, Dion 747, 886
Dvorak, Leona P. 376
Ekhaml, Leticia 831
Engelking, Jeri L. 410, 500
Erb, Dorothy 437
Ervin, Jr., Joseph R. 730

Espinoza, Sue 592, 626
Feng, Yuan 816
Fernández, Maria Teresa 503
Fineman, Elissa 820
Fishburne, Graham 493
Flake, Jan 335
Fleener, M. Jayne 742
Floyd, Emmett M. 603
Forbes, Jacqueline 185
Forcheri, Paola 176
Ford, Mary Jane 136
Frew, Thomas W. 480
Fulton, Kathleen 801
Futoran, Gail Clark 661
Galloway, Jerry P. 507
Gentsch, Karen 747
Gershner, Vera T. 511
Geyer, Roger 579
Geyer, Roger W. 587
Gillan, Bob 886
Golden, Constance S. 437
Gordon, Myles 160
Goss, Marlene 683
Grandgenett, Neal 743, 840
Greene, Bert I. 631
Greer, Edrie 128
Grejda, Gail F. 442
Griffey, David 648
Grover, Robert 621
Gunn, Cathy 596
Gunter, Glenda A. 348
Haakenson, Paul 488
Haner, Kerry 729, 808
hannah, c. lynne 477
Harlow, Steven 390, 581, 814
Harnisch, Delwyn L. 180
Harris, Judi 672, 706
Heath, Marilyn 1, 888
Heide, Susan D. 824
Henrichsen, Lynn E. 91
Herrin, Margie 265
Higdon, Janice 310
Hoadley, Michael R. 410, 500
Holifield, Mitch 401
Hooper, Judith 210
Howard, Dale C. P. 668
Howard, Peggy Ann 668
Hower, Robert F. 86
Huang, Shwu-yong L. 769, 781
Hudspeth, DeLayne 167
Huerta-Macias, Ana 17
Huller, Craig 497
Hunt, Nancy 53, 834
Hutchinson, Art 86
Hutchinson, Elaine 69
Jenkins, Diana 29
Jenson, Robert A. 500
Jin, Seung H. 719, 729, 808
Jinkerson, Lorana A. 451, 761
Johnson, D. LaMont 390, 581, 814
Johnston, Jerome 805
Jones, Greg 186, 672
Jones, W. Paul 774
Kay, David 219
Kazlauskas, Edward John 851
Kempf, Isabell 32
Kester, Diane D. 652
Kirkwood, David 394
Kiser, Lara 677
Knee, Richard 556
Knezek, Gerald 186
Knupp, Blaine E. 294
Kolloff, MaryAnn 516
Kortecamp, Karen 283
Kraus, Lee A. 758
Kraus, Sharon K. 758
Kung, Sonja 69
LaHaye, Sue 273
Lambert, Lynn 357
Land, Betty Lou 132
Larson, Janice 1, 888
Leavell, Judy A. 287, 693
LeBlanc, Patty 362
Lee, Doris 567
Lemons, Linda McDonald 383
Liao, Yuen-kuang Cliff 61
Linek, Wayne 747
Liu, Min 519
Lloyd, Eric 341, 637
Long, Shirley A. 516
Lumpkins, Bob 265
Lynds, Beverly T. 160
Lyons, Veronica J. 753
Mackie, Brian G. 564
Maddux, Cleborne D. 390, 581, 814
Makurat, Phillip 600
Manuel, Monique 519
Manus, Alice 735
Marcinkiewicz, Henryk R. 876
Martin, David M. 259
Martinez, Joseph G. R. 376
Marx, Steven 78
Matthew, Kathryn I. 107
Maxey, Dennis 167
Mazulewicz, Jake 543
McCracken, Kevin 488
McCraw, Phyllis A. 268
McDevitt, Margaret 322
McEneaney, John 747
McGee, Patricia A. 643
McIntyre, Susan R. 414
McKenzie, Barbara K. 419, 764
McKinney, Marilyn 774
McKinzie, LeAnn 626
McLean, S. Vianne 110
McMann, Gregg 665
McManus, Thomas 464, 715
McPherson , Sarah 892
Mergendoller, John R. 805
Merideth, Eunice M. 638
Meyer, Jane E. 268
Miller, Robert 366, 656
Mims, Nancy G. 419
Molfino, Maria Teresa 176
Molina, Laurie 335
Moore, David 186
Moore, James C. 876
Morris,William R. 86
Mortenson, Robert 743, 840
Moser, Cheryl 447
Murphy, Diane T. 348
Murphy, Karen L. 614
Murray, Marshall R. 91
Muscella, Deborah 205
Nath, Janice L. 261
Nelson, Mike 197
Norris, Peter 429
Norton, Priscilla 371
Ormsby, Harold 25
Orzech, Mary Jo 690
Oughton, John M. 730
Ouyang, John Ronghua 305
Padron, Yolanda N. 93, 769
Pan , Alex C. 118, 197, 567
Papalewis, Rosemary 844
Paprzycki, Marcin 45
Parker, Fred 265
Parmley, Dianna L. 86
Parmley, John D. 86
Peelle, Howard A. 171
Persichitte, Kay 379
Poe,Virginia 136
Pokay, Patricia A. 148
Poole, Dawn 140
Pracek, Eileen 889
Price, Jerry 404, 468, 554
Quinn, Linda F. 774
Raiford, Peg 318
Rautenhaus, Heike 124
Rayborn, Kay 265
Redfield, C.L. 210
Reed, W. Michael 730

Reehm, Sue P. 516
Riley, James 631
Riley, John F. 259
Ritchie, Donn 429
Robbins, Jerry 631
Robin, Bernard . 341, 366, 637, 656, 710
Robinson, Brent 40, 341, 637
Robinson, David 705
Rockman, Saul 805
San Nicolas, Anthony C. 609
San Nicolas, Gregg C. 609
Samer, Ronald 427
Scheffler, Anthony J. 394
Schmidt, Rodney 250
Schneiderman, Bette E. 685
Schroeder, Eileen E. 648
Schroeder, Gary G. 455
Schultz, Theron Ray 341, 637, 680
Schuttloffel, M. J. "Mimi" 859
Seifreit, Carol A. 677
Silvennoinen, Martti 301
Simonson, Michael 142
Slaughter, Bernadette Cole 294
Smith, Dorothy R. 297
Smith, Kathryn A. 423
Smith, R. Michael 398
Smith, Terry R. 423
Smith-Gratto, Karen 828
Smyth, Thomas J.C. 524
Snider, Sharla L. 511
Southworth, John 186
Sprague, Debra 352
Srirengan, K. 66
St. Clair, Connie 213
Staudt, Denise 122
Stephens, Liz C. 254
Strang, Alice 541
Strang, Harold R. 541, 543, 546, 550
Strudler, Neal 834, 774
Stuhlmann, Janice M. 273, 868
Sullivan, Gene 526
Swartz, John A. 531
Sweeder, John J. 894
Tarter, Curt 434
Tayeh, Carla 148
Taylor, Chris 223
Taylor, Harriet G. 273
Taylor, Rhonda 132
Tellep, Andrew 778
Tellep, Michele M. 778
Thirunarayanan, M. O. 201
Thompson, Ann D. 883
Tidler, Karen L. 376
Tipton, Pamela E. 434, 863
Toni, Perle 37
Topp, Neal 743, 840
Toth, Eva Erdosne 191
Trezise, Kathleen 696
Troutman, Andria 213, 677
Twining, Peter 879
Ubermanowicz, Stanislaw 45
Vagle, Royle 230, 238
Valmont, William J. 571
Varagoor, Gita 404, 537, 554
Vidakovic, Draga 45
Wagner, Sharon 163
Walsh, Clare M. 537
Waxman, Hersholt C. 93, 769, 781
Wentworth, Nancy M. 244
Wertheimer, Richard 661
Wetzel, Keith 110, 278, 434, 834,
Wheatley, Betty 128
White, Cameron 75, 290
White, James 213, 533
White, Steven H. 83
Wiburg, Karin M. 17
Will III, Oscar H. 443
Will, Katherine 443
Williams, Hilda Lee 638
Williams, Nancy L. 107
Williams, Susan 140
Willis, Dee Anna 1, 791, 795, 888
Willis, Elizabeth M. 331, 376
Willis, Jerry 537, 575, 710, 729,
791, 795, 801, 805, 808
Wong, Ray E. 398
Wright, Bruce 588, 725
Wright, Lily L. 329
Yeager, Evan 592
Yeh, Yu-chu 546
Zambo, Ron 278
Zarinnia, Anne 648
Zbikowski, John 118
Zhang, James Y. H. 329
Zimmerman, Sara Olin 618, 750
Zimmerman, Ward 618
Zimmerman, Ward Alexander 750
Zimmerman, Ward Brian 750

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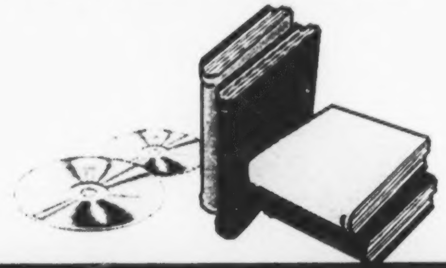

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